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TWO NEW RECORD-BREAKING OFFICE BUILDINGS IN NEW YORK CITY.

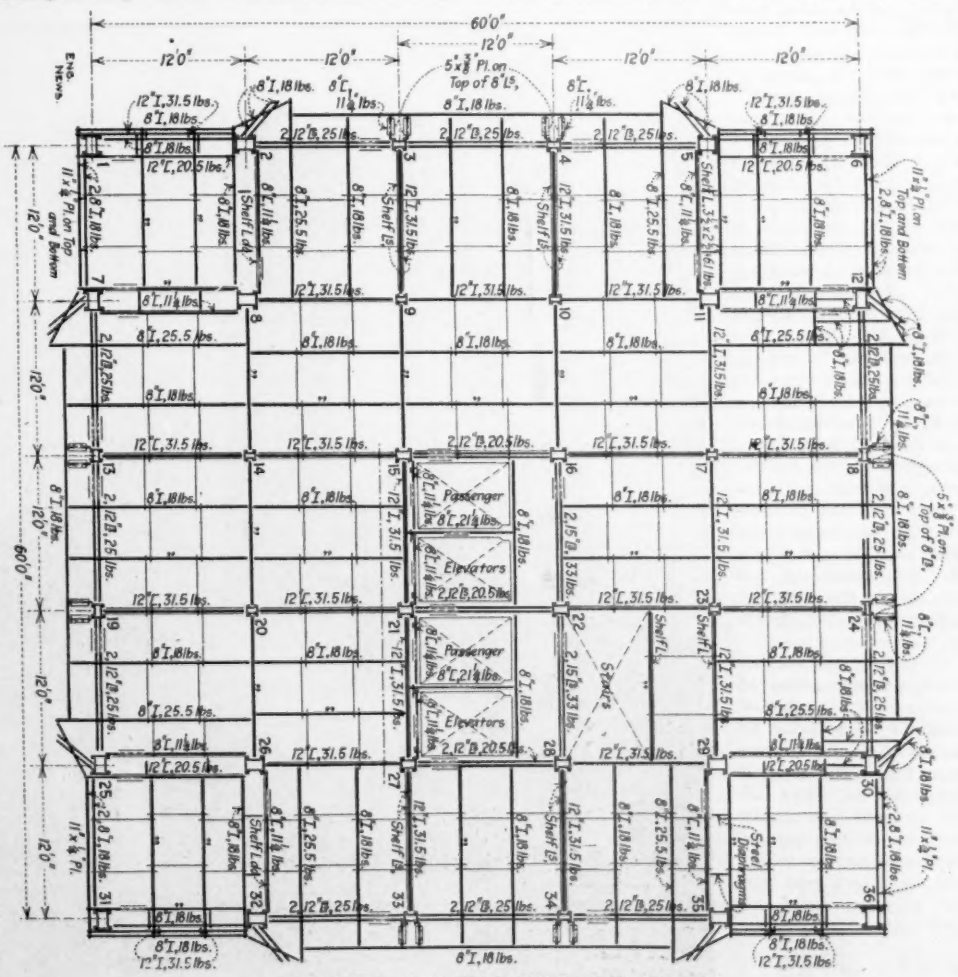
There has rarely been a period of more than a few months in the last decade when the "largest office building" was not in process of construction in New York City. So rapidly has the erection of these immense skyscrapers progressed that the interest in the latest one has usually not been more than a matter of passing moment or an object of interest to the sightseeing tourist.

At present, however, there are four record-breaking buildings under construction in New York City, the Metropolitan Life tower (Eng. News, Jan. 31, 1907, p. 138), the Church St. Terminals (Eng. News, Jan. 3, 1907, p. 14), the Singer tower and the City Investing Building. The first of these will have the highest tower in the world, except the Eiffel Tower; the second will have the largest floor area ever found in an office building; the third, the Singer tower, while a few feet lower than the Metropolitan Life tower, will be finished some months before the latter and therefore for a short time will hold the record for height; and the City Investing Building will be the tallest building which carries the major portion of its area to its maximum height.

The half-tone reproduced in Fig. 4a is from a photograph taken on Sept. 25th, 1907, from the offices of Engineering News on the 19th floor of the St. Paul Building, about 200 ft. from the ground. The view is down Broadway and shows in the foreground, first the 32-story City Investing Building at this time about 22 stories high, and behind it the 41-story tower of the Singer Building, on which the light lantern columns alone then remained to be completed. Fig. 4b was taken from the same viewpoint on Nov. 8th and shows the Singer tower completed and the City Investing Building at about the 25th story. These two buildings, which will be finished about the same time, cover most of the block enclosed by Broadway, Liberty St., Cortlandt St. and Trinity Place. They are being built by separate companies under separate contracts to different firms, and although they are not alike in any of the details of their construction, their simultaneous erection on adjoining lots and the magnitude of the operations involved in their construction, lends to them a companion interest. For this reason we have treated the two in this one article.

Singer Building.

The new Singer Building is a combination of two old steel frame buildings on the corner of Broadway and Liberty St. with an adjoining new structure fronting on Broadway and extending back to the same depth as the two old lots. The old buildings, originally 11 stories, have been raised to 14 stories and the new structure consists principally of a 41-story tower with a four tier lantern which rises to a total height of 612 ft. above the sidewalk, some 46 ft. lower than the Metropolitan Life tower, but otherwise the highest piece of construction on this side of the ocean. The architectural treatment of the new portion has been made to harmonize with the old, a particularly ornate design with a red facing wall trimmed with white stone window casings and cornices. The slender square tower, with its gracefully tapering cupola and tall lantern lookout, rising far above the mass of high buildings of lower Manhattan, adds a striking landmark to that already picturesque skyline.



TYPICAL FLOOR PLAN ON SINGER TOWER.

There is a total floor space in the building of 9½ acres, there being 20,000 sq. ft. available on each of the 14 floors of the main portion and 3,300 sq. ft. on each of the tower floors, in no one of which are there any inside rooms. There are four elevators rising to the fourteenth floor and four more to the 35th floor, which is the last floor in the square section of the tower. Above this the curved cupola rises to the 40th floor, at which point the lantern starts. There are really 48 so-called tiers or levels of horizontal beams, this including certain mezzanine floors and the small area landings in the lantern.

The entire building is of skeleton steel construction, fireproofed with terra-cotta tiling and provided with terra-cotta floor systems surfaced with cement. The columns are founded on concrete footings sunk by compressed air caissons some 90 ft. below street level to bed rock. Except in three cases (See Fig. 2) these concrete footings are arranged so as to each carry a pair of columns, the load being distributed from the column through cast steel bases to a single I-beam grillage, made up in some cases of I-beams as large as 24 ins.

The customary practice is followed by placing the concrete footing and I-beam grillage so that the differing loads on the two columns will center over the center of gravity of the footing. In two of the three cases where a single column bears on a footing, small circular caissons were driven and in none of these three was an I-beam grillage used, the steel castings resting directly on the concrete.

Fig. 3 illustrates the heaviest of the cast steel shoes used for column bases. This base will have a computed load of 747 tons without wind and 868 tons with wind acting. The bases are made out of mild steel, with a very high specified elongation test. A great deal of trouble was experi-

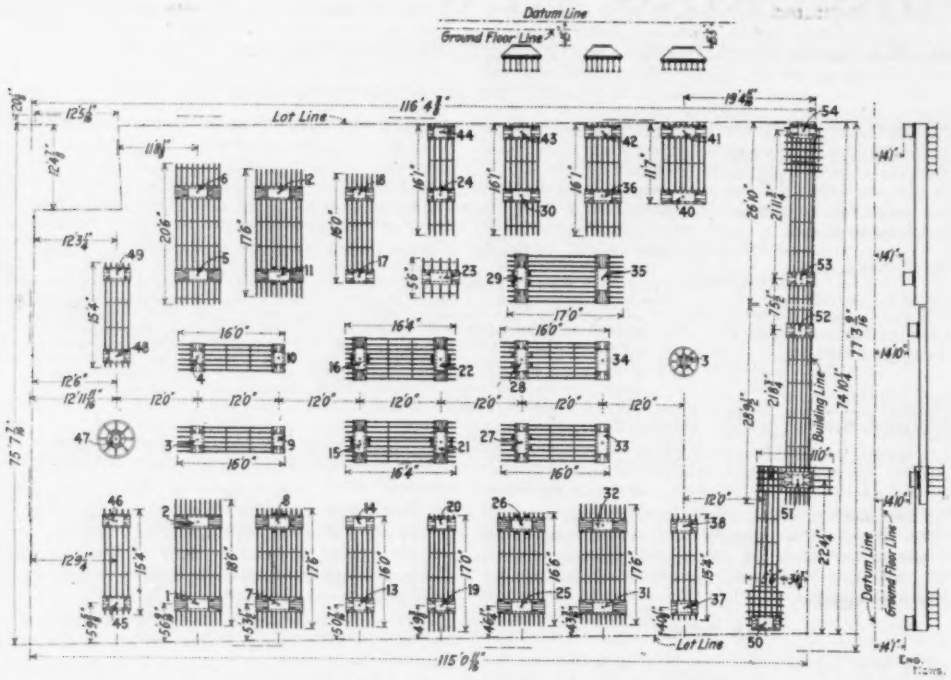


FIG. 2. FOUNDATION PLAN OF SINGER BUILDING.

enced in testing the material, as the metal provided by the shop would not show up well enough in the elongation tests. Finally, the inspection requirements were satisfied and the shoes as placed have not shown any weak places as yet.

The structural details of the main 14 stories have nothing out of the ordinary. The columns are spaced uniformly at 12 ft. c. to c., connected at right angles by I-beam wall and floor beams. The corners and elevator shafts are wind braced with diagonals as described below, but there is no horizontal floor or wind bracing. The columns are made up of a double channel section, enlarged, where needed, by the addition of flat plates. The largest column is shown on Fig. 10 and consists of two 15-in. channels, four 20 × ⅞-in., two 20 × ¾-in., eight 14 × 13/16-in. and two 12 × ½-in. plates, a total section of 235 sq. ins. for a total load of 3,400,000 lbs. These columns have a standard length of 13 ft. 4 ins. between floors. The outside columns stop at the 36th floor, above which outside walls are carried on curved double-channels (Fig. 5); the inside columns still continuing. Above the 40th floor the lantern construction is carried up with light angle columns to a smaller cupola formed with curved angle columns. A steel flag-pole, not shown on the drawing, passes through the hole in the very top of the cupola and is anchored in the socket shown at the 43rd floor.

The wind bracing on the tower is of extraordinary interest. On account of the small section of this tower and the necessity for as much window space as possible it was deemed inadvisable to cross-brace the entire structure or even its entire faces. As will be noted from Fig. 1 the plan of the tower is divided symmetrically into 25 squares each 12 ft. on a side, by columns running from foundation to the beginning of the cupola. The tower is wind braced and stiffened by treating each one of the corner squares as a separate tower and bracing it on all four of its sides by crossed diagonal struts. In addition the three closed sides of the elevator shafts are treated in a similar manner. Fig. 6 will illustrate this layout, the squares 3-4-10-9 and 10-9-15-16 being elevator shafts for the first 14 stories in the main building. In designing this bracing the loads were adjusted as follows. It will be noticed that in a north and south direction there are 11 lines of wind bracing in the tower, very nearly symmetrically distributed. It was therefore assumed that on each story, each line of X-bracing took 1/11 of the total wind pressure for that story figuring at 30 lbs. per sq. ft. as per the New York Building Regulations. In an east and west direction, the corner towers are symmetrical, but the elevator shafts must have openings for entrance, thus preventing bracing on one side and leaving but two sets of bracing in this line in contrast to the three on the other. In order to make a proportional bracing on all sides of these elevator shafts, then, the stresses in the two lines of bracing 16-22 and 22-28 were increased by 50% over those used in figuring all the others. The stresses acting in each of these towers and the size of bracing are shown diagramatically in Fig. 7. The inside bracings are arranged evenly, one cross brace to each floor, the floor beam acting as the horizontal member.

The exterior bracing is arranged differently on account of the necessity for openings. This consists of a long and a short panel, each cross-braced and with the horizontal members coming

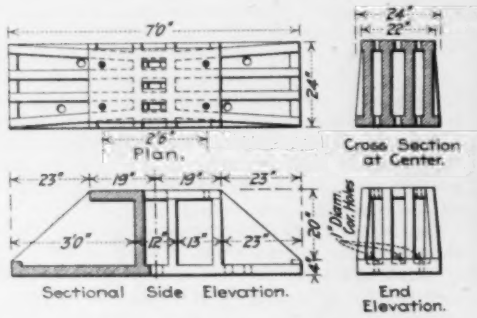


Fig. 3. Cast Steel Shoe for Column Bases in Singer Building.

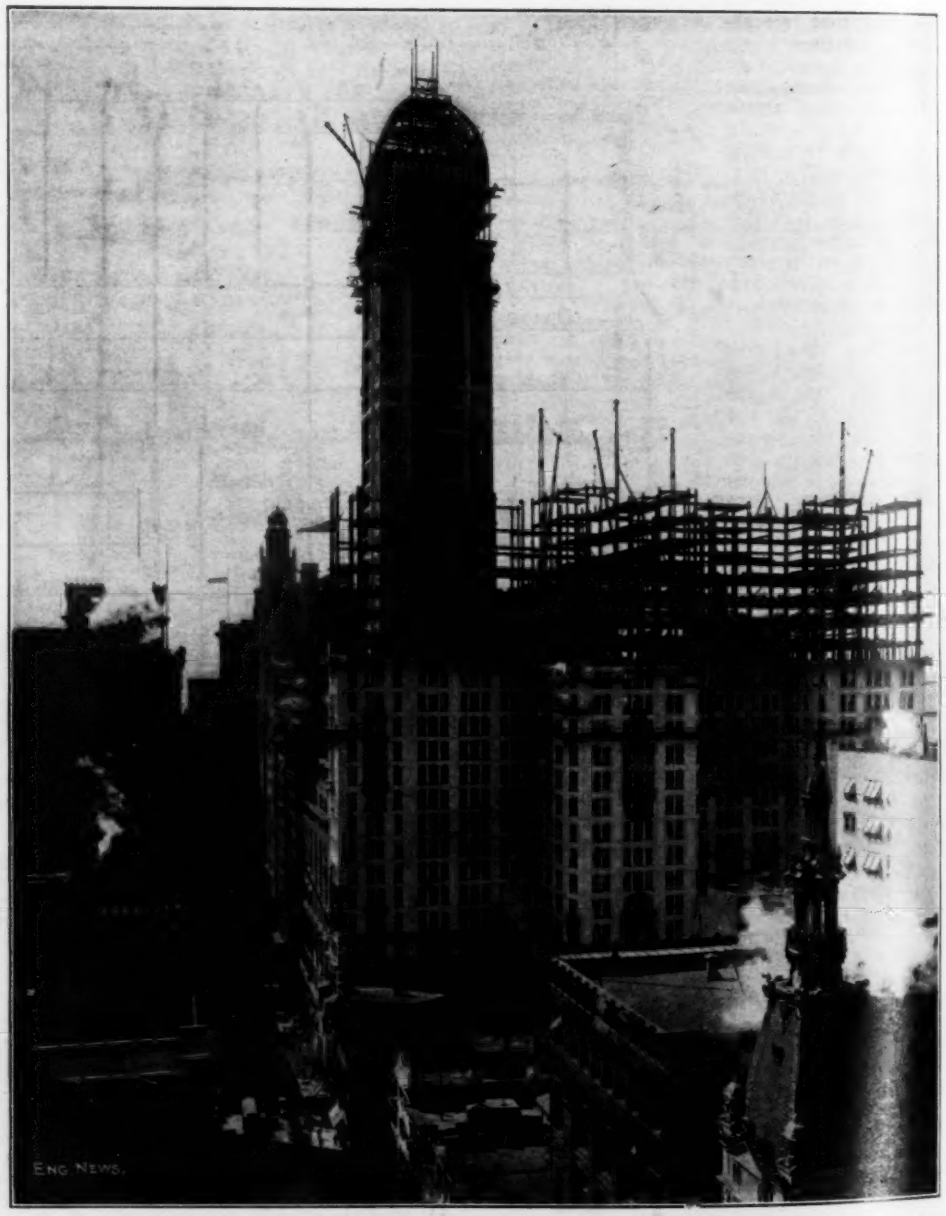


FIG. 4a. THE SINGER AND THE CITY INVESTING BUILDINGS IN COURSE OF CONSTRUCTION.
(View taken from the 19th floor of St. Paul Building, looking down Broadway, Sept. 25, 1907.)

between floors. The windows then occur in the openings of the large panels. The bracing throughout consists of double crossed channel beams, with their flanges facing in the same direction, one of each set being cut and passing the other with a riveted plate. (Fig. 8.) Above the 36th story no wind bracing was provided.

In designing the wind bracing in this manner, that is, in assuming each of these small 12 × 12-ft. towers to be independently capable of taking wind stresses, a theoretical uplift is exerted on each of the bases of the columns at the corners of the braced towers. To provide for this uplift, these columns were anchored into the concrete caissons on which they rest. All of the outside columns carry an extra dead load due to the weight of the brick walls largely exceeding the uplift from the wind and therefore no anchors were provided for them. On columns 11, 29, 26, 8, 15, 16, 21, 22, 27, 28 (See Fig. 6) these anchors were placed.

The details of these anchorages are shown in Fig. 9. A small angle iron grillage was embedded in each one of the caissons as it was built and in such a position that when the caisson reached its bearing the grillage would be at approximately an elevation 60 ft. below datum. To this grillage there were fastened flat plates increasing in number and in size as they neared the top of the concrete and connected with pins. Originally it was intended that these connecting bars should be round rods but owing to delays in manufacture these flats were substituted.

As the caissons do not always sink in a straight plumb line, cast rocker-saddles were provided to be put in about 20 ft. below datum by means of which the anchors above could be adjusted into a plumb line. Details of this rocker are shown on Fig. 9.

From these rockers the anchor is made of two round rods 3½ ins. in diameter in columns, 15, 16, 21 and 22 and 4½ ins. in diameter in the other anchorages. These rods pass by the grillage between the I-beams and outside the cast-steel bases up to a saddle riveted to the column.

This saddle consists of a block, spanning the heavily plated ribs which are riveted up the column for a distance of from three to five feet, varying on the different anchorages. These saddle blocks are notched on both sides so as to engage with similar lugs on the ribs and thus make a firm, immovable bearing.

In those columns, where the blocks spans have but two vertical ribs, a lower lug or projection is provided to give additional strength. The anchor rods pass through these blocks and are fastened thereto with nuts and washers which are easily accessible and can be inspected and tightened at any time.

The detail of the base of the column with its additional heavy plates is shown in Fig. 10. Up to the present, when the entire steel work is finished and the brick face walls up to within a few stories of the top, this system of wind bracing has proved remarkably efficient; the tower is one of the stiffest steel structures in New York City.

The steel construction is in many ways peculiar, particularly in the treatment of the wind stresses. There has never been an exactly similar solution of the problem, although it is true that there has never been precisely this same problem of a very high and slender steel tower used for office purposes.

Throughout the work it is evident that it is an architect's design in which structural detail has been subordinated to architectural considerations. This is noticeable in the trumpet arch construction at the 34th floor just below the bay windows of the upper cupola. This has the appearance of a stone arch capable in itself of sustaining its own thrust but in reality the overhang was so great that the consulting structural engineers required a series of cantilevered beams to be built out above the arch and each voussoir to be hung from a beam by rods wedged into dog holes cut in the upper face of the stone. As the abutment of this heavy arch was originally only an 18-in. stone, the design was, at least, bold.

The Singer Building is being erected by the Singer Manufacturing Co. The architect is Mr. Ernest Flagg, to whom is due the entire design and supervision of the structure. Messrs. Boller and Hodge are consulting engineers on the structural work. The Foundation Co. of America had the foundation contract and Milliken Bros. the structural steel work.

FIG. 4b. THE SINGER AND CITY INVESTING BUILDINGS IN COURSE OF CONSTRUCTION.
(View taken from same point as Fig. 4a, on Nov. 8.)

City Investing Building.

This building occupies the entire frontage of the south side of Cortlandt St. between Broadway and Trinity Place, but owing to difficulties in obtaining the corner property at Broadway and also to the architectural treatment of the light shafts, which are recesses in the front of the building instead of the usual interior shafts, the plan of the building is singularly irregular. The main building rises to a height of 25 stories, capped on the narrow Broadway front by a small tower, and that portion between the Cortlandt St. wings reaches, for a section about 70 ft. square, to a height of 32 stories, the last three stories of which are in a sloping gable, rising about 400 ft. above the street. It is of the usual steel construction, faced with white stone for the first six stories and above that with white brick and terra-cotta trimmings. The most striking architectural feature of the building is a three-story arcade which extends from the Broadway front clear through the building to Trinity Place. This arcade opens into Broadway in a magnificent arched portal, the artistic treatment of which makes it one of the finest entrances ever placed in a building of this sort.

Owing to the proximity of existing buildings and to the simultaneous erection of the adjoining Singer Building, some portions of the old parts of which had to be underpinned, considerable difficulty was experienced in laying the foundations. The column footings were all carried down from the basement level, about 30 ft. below the street, to a few feet below hard pan, by the use of compressed air caissons filled with concrete. Each of the interior columns foots on a single square concrete base (Fig. 11) for which small caissons were used. As the wall columns rested on grillages which cantilevered over from adjacent footings, these latter were much larger and rectangular in shape. The steel bases and cantilever girders which carry the columns are described below.

The structural features of the building do not vary from ordinary practice in many instances. Some of the details which are unique or worthy of description on account of their magnitude are noted below. In general the structure consists of columns spaced about 22 ft. c. to c., connected in the walls and in the main girders by floor girders of twin I-beams which in turn are connected by single floor beams of I section. The first two floors are each 22 ft. high and above that the floor spacing is 14 ft. All the plan layout is rectangular with the exception of the peculiar radial beams at the elevator shaft and the cor-

ners of the Cortlandt St. wings. The special points of interest in the design are the heavy foundation bearing-girders, the cast-steel shoes, the bracing over the arcade, the wind-bracing and the columns; the latter on account of the reawakened interest in large columns since the fall of the Quebec Bridge.

Fig. 13 illustrates the immense foundation girders on which the outside columns rest. These girders are founded on I-beam grillages set in the concrete of the caisson-filled footings. The lower drawing in the figure shows the cantilevered column bearing at the inside face of the building where the adjoining foundations of the Singer Building prohibited the sinking of caissons.

These girders are made up of three heavy plate girders, 84 ins. deep with flanges of 8 × 8-in. angles and two ⅞-in. plates and a web of one ⅝-in. and two 5/16-in. plates. They are heavily stiffened under the columns with 6 × 3½-in. angles. The girders are bedded in cement grout on the I-beams. The columns rest on steel castings (described below), resting in turn on hot pressed plates on the girder upper flanges.

The upper drawing in Fig. 13 shows the girder bearings, at the Broadway wing under the arcade, supporting the columns shown in Fig. 16. These are the largest footing girders used in the building. They are made up of three plate girders, each 96 ins. deep, with a web of one ½-in. and two 5/16-in. plates and flanges of 8 × 8-in. angles with three 1-in. cover plates. Their general details are similar to the cantilevered beams noted above, but owing to the two columns being so close together, the ends of the girders are provided with extra heavy stiffening.

The interior columns are founded on single grillages, shown in Fig. 11, made up of one or two crossed I-beams, carrying a cast steel shoe. The smaller of these shoes were cast in one piece as is the customary practice, but owing to the danger in casting and the liability of shrinkage cracks in large masses, the heavy castings were made in two pieces.

These latter (Fig. 12) consist of two separate webbed castings, each planed on both horizontal faces and bolted together so that the general pyramidal shape will spread the stresses to the concrete footings. These separated castings have given the greatest satisfaction, there has not been the slightest trouble in casting and the details of setting and moving have been greatly simplified over the methods in use in similiar single castings.

On account of the arcade through the building, the Broadway wing above the third floor is carried upon plate girders spanning the arcade and resting on extra heavy side columns. The detail of this construction is shown on Fig. 16. The side columns, founded on the grillage shown in Fig. 13, are formed of two regulation section columns, acting as one, tied together beneath the first floor by a lacing and from the first to the third floor by a diaphragm plate. The third floor, with its bearing columns, is carried upon these side double columns on a plate girder about 32 ft. long and 87 ins. deep, made up of flanges with 8 × 8 × ⅞-in. angles and two ¾-in. plates and of two ½-in. webs, riveted to opposite sides of each flange angle. These girders are braced together by a heavy truss made up of I-beams and angles. A curved bracket transmits the reaction into the columns.

The wind stresses are taken up by an increased rigidity of the rectangular connection between the wall columns and beams. That is, the inside half of the flanges of each twin I-beam is cut away where the beams cross a wall column and the web of the beams riveted, with as many rivets as the area will take, to the vertical side plates of the column. Horizontal stiffening plates are then riveted to the remaining half of the floor beam flange to make up for the material removed. (See Fig. 16.) This makes a remarkably stiff connection capable in itself, without the use of any other diagonal or knee bracing to take up wind stresses. This method has been previously used by the consulting engineers on the Trinity Building with great success in stiffening the structure. Fig. 15 shows sections of a typical heavy column from the sub-basement to the 32d floor. The largest section that at the sub-basement, has a maximum area of 253.6 sq. ins. to carry a load of 1,719 tons. It will be noticed that in this column design, wherever a change in section occurs, the superposed column always has at least its own full area to bear upon; that is, the taper is on the outside and only in a few instances does the section span an opening in the one next below it. The building is being erected, at an estimated cost of $10,000,000 by the City Investing Co. of New York. The architect is Mr. Francis H. Kimball, the consulting structural engineers, Messrs. Weiskopf & Stern, and the general contractors the Hedden Construction Co. The O'Rourke Engineering Construction Co. put in the foundations and the steel work is being erected by Messrs. Post & McCord. The building is expected to be ready for occupancy by May, 1908.

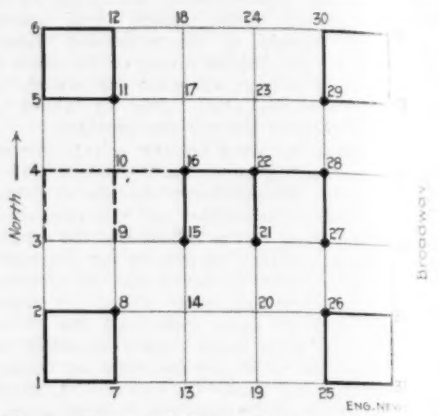


Fig. 6. Singer Building. Plan Layout of Wind Bracing.

Heavy full lines indicate wind bracing to 33d story on corners, to 36th story on interior.
Heavy dotted lines indicate wind bracing to 14th story (main building).
Fine lines indicate no diagonal wind bracing.
Circles on column intersections indicate anchor bolts.

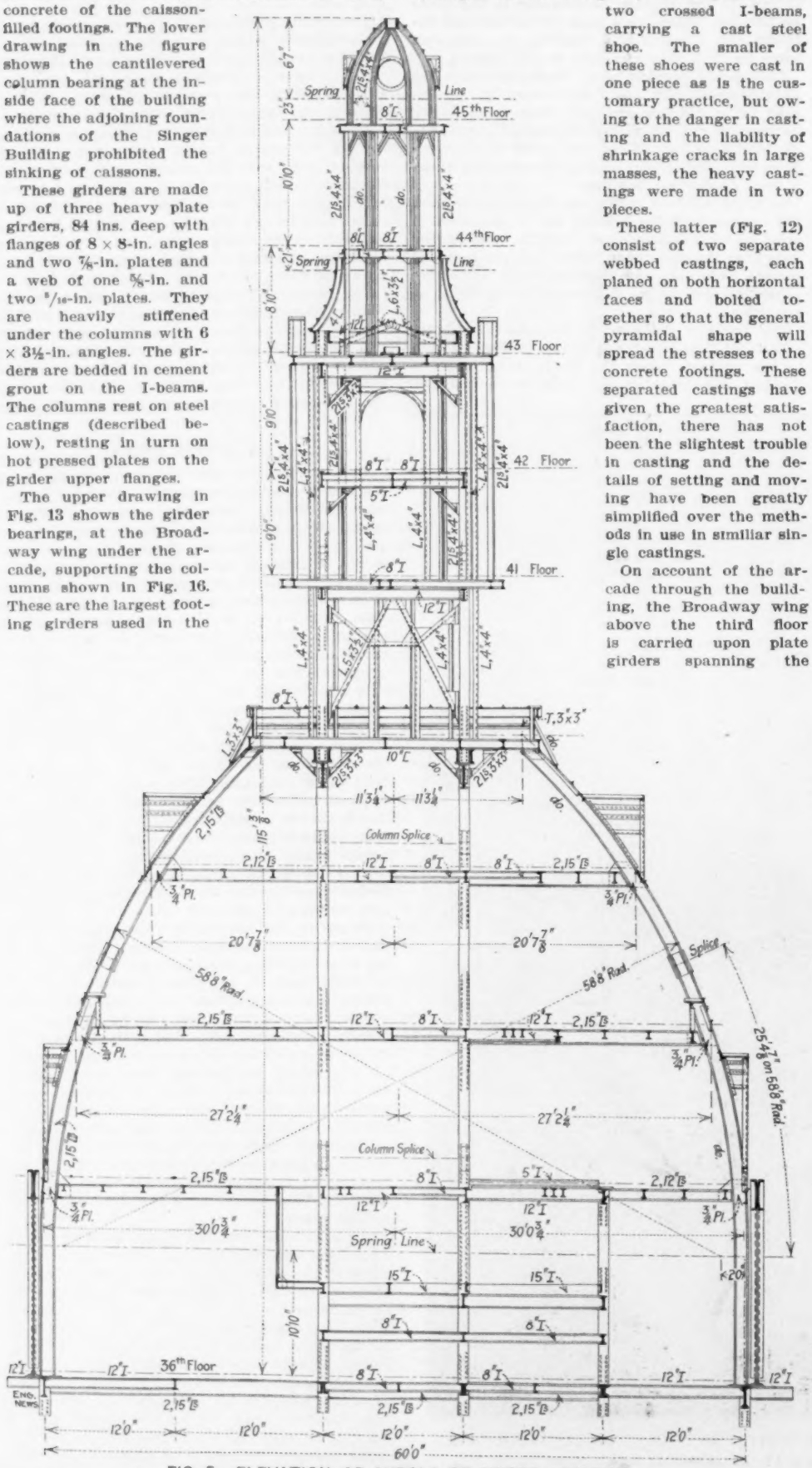


FIG. 5. ELEVATION OF CUPOLA OF SINGER BUILDING.

A LONG REINFORCED-CONCRETE BRIDGE has recently been completed to carry the tracks of the Lima and Toledo Traction Co. across the Maumee River at Waterville, O. The bridge is 30 ft. wide and 1,220 ft. long, and consists of 12 spans increasing in length from 15 ft. at each side to 90 ft. in the center, with a crown thickness of 2 ft. and a haunch thickness of 4 ft. 6 ins. The quantities comprise 10,000 cu. yds. of concrete, 240 tons of reinforcing steel and 60,000 cu. yds. of earth fill. It was built by the National Construction Co. under the Luten patents for reinforced-concrete bridge design.

THE CONSTRUCTION AND REPAIR DIVISION OF THE CITY OF CHICAGO.

By WILLIAM D. BARBER,* M. Am. Soc. C. E.

The city of Chicago has as a part of its Engineering Department a Division of Construction and Repairs, of which the writer has been in charge for about eight years. This Division has charge of all additions, alterations or repairs upon buildings owned by the city. It does painting, plumbing and roofing, lays cement sidewalks, makes pails, street lamps, gutters, rainwater leaders and skylights. For the Water Department it repairs water meters, valves and hydrants, does machine work to maintain the city pumping engines and drawbridges. The staff comprises the Chief of the Division (as Engineer in Charge), an estimating engineer, architectural draftsman, office men (bookkeepers, clerks, etc.), inspectors, foremen, and from 300 to 500 mechanics and laborers. It has two shops; one at 22d St. and Ashland Ave., and the other at 14th St. and Michigan Ave. The former has a pattern shop, machine shop and brass foundry. Meters are repaired, and the Water Department has a meter-testing apparatus adjacent to the machine shop. At this plant patterns are made for large and small work, hydrants, valves, etc.; and the iron castings (made by contract from these patterns) are machined and assembled. The other plant has a carpenter and cabinet-making shop, tin and sheet iron shop, paint shop, and storage rooms. It is hoped later to combine these shops in one plant.

The writer first took up the work of city civil engineering in Chicago some twelve years ago, and during this time he has been a careful student of the problems that confront the engineer on city work. Municipal work of all kinds, whether done by contract or by day labor, has been excessively costly, and in most cases represents small returns for the amount of money spent when usefulness, durability and quality of the work performed is considered. It has been said that in Chicago before the civil service law went into effect a few years ago, it was not a question of city employees doing work for the city, but for the political or other interests of the men who secured them the job. Now, however, the condition is radically changed, and under proper regulations the best, cheapest and most durable work can be secured by city day labor.

The object of this article is to show how the Construction and Repair Department in Chicago has been organized and put upon a business basis, with systems of records and methods of keeping track of both labor and materials, such that the efficiency of the work done and ultimate usefulness and value rendered the city is superior to anything that has been accomplished in city work before. If extended and allowed to operate fully and freely, it will save the city millions of dollars and give it municipal improvements of the highest character.

My method has been to take the facts that have entered into city work which has been under my control or observation, and from these facts build up a system that is thorough, businesslike, and accomplishes the desired end.

Eight years ago, after some four years' experience on city contract work where litigation, extras and poor work had run the cost of municipal improvements to an excessive figure, I was given a small force of city laborers and told to see what I could accomplish with them. At that time no records were kept of the work done, no system was in existence to show whether the work that was done was costly or cheap, and no effort was made to save materials left over after a job was finished. These materials were either spirited away, or thrown aside to await developments should they ever be needed. My eight years' work has been filled with all kinds of opposition and discouraging circumstances, all of which have not as yet been fully overcome, but the road has been blazed, and all signs now point to a practical solution of the problem.

When I took up the work I found the existing conditions as follows: (1) Waste of materials and time spent on the different jobs ordered; (2) poor quality of labor; (3) no system or method of keeping track of the labor or materials that entered into the work, from which one could establish a system of standards; (4) costly delays on work caused by not being able to get materials when needed; (5) political influences that tended to cause insubordination and a disregard of orders issued by the person in direct charge; (6) lack of proper and experienced foremen to supervise the work; (7) no system of billing against the different departments for work done, or of checking materials and labor and having bills properly scrutinized and checked by the department having work done; (8) no rules to govern the different kinds of work done; (9) no method to safeguard the city as to waste of tools, neglect of duty, drinking, and other points that have to be closely watched in order to get efficient work from employees; (10) antiquated machinery, shops not properly laid out, and inadequate space for handling goods and doing work.

The problem of securing efficient labor has been solved in the best way by putting into force the present city civil service laws. These enable the best laborers and skilled workmen to be secured by means of competitive examinations, both theoretical and practical. Take, for illustration, a call for carpenters. Each applicant gives a statement covering his experience on carpenter work. He also answers a series of questions regarding materials used, laying out of work, and other items covering what a carpenter should

*Head of the Division of Construction and Repairs, City Hall, Chicago.

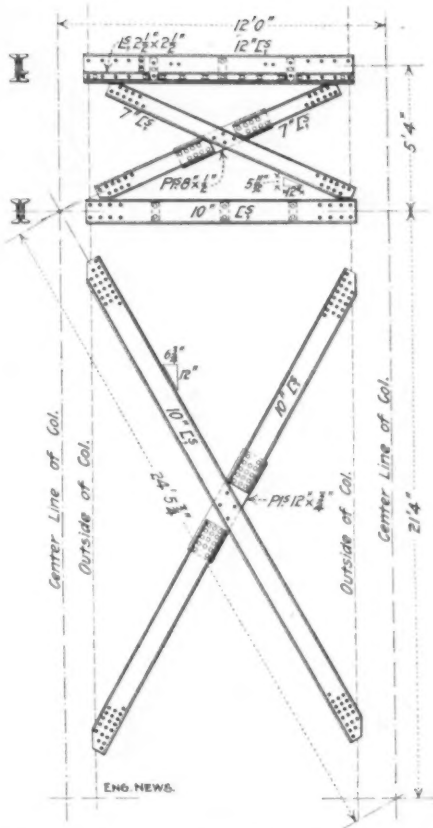


Fig. 8. Details of Singer Building Wind Bracing.

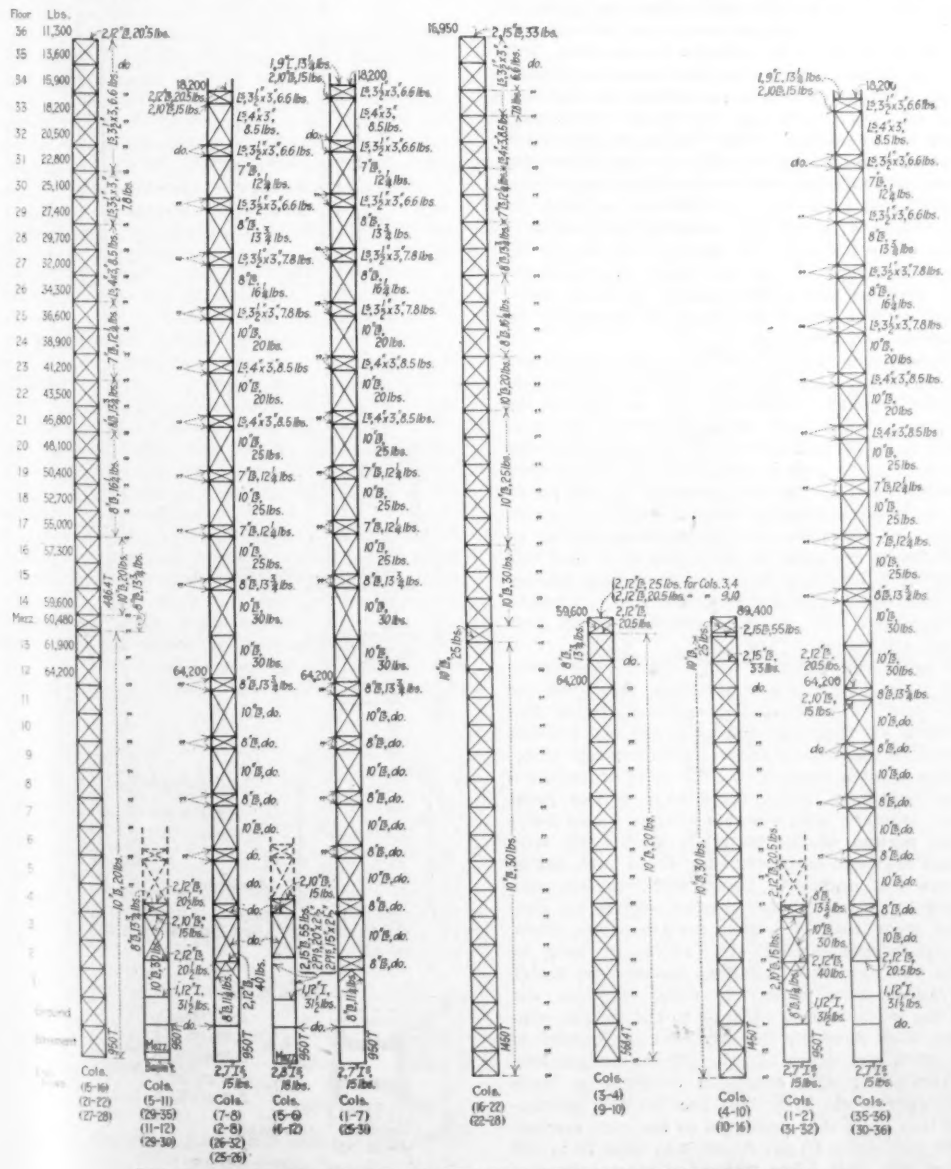


FIG. 7. DIAGRAM ELEVATION OF WIND BRACING, SINGER BUILDING.

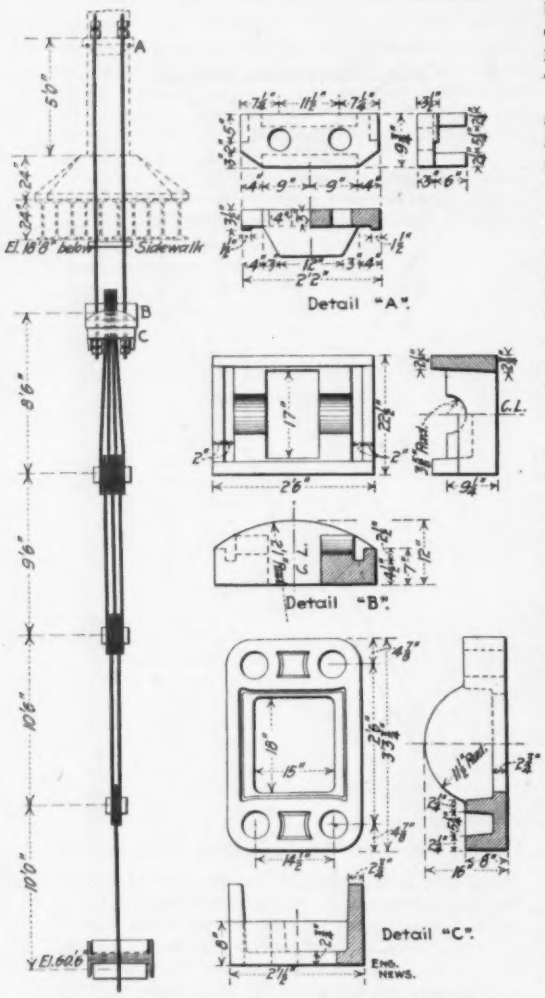


Fig. 9. Anchorage on Singer Building Columns.

know. Then he is given certain work to do, and on each part is given a mark in accord with the answers or sample of work turned out. After this examination the candidates who pass are placed on the eligible list in the order of their demonstrated efficiency, and when a call is made for carpenters the highest on this list are chosen first. The same rule applies to all other labor employed to do city work.

In trying to accomplish the best and most efficient results in city work, one finds such opposition and delay in all points brought up for consideration that each step at the best must be slow and accomplished with great effort. I found my small force doing work under the direction of numerous bosses, and being ordered about on any and all sorts of work. The first move was to divide the force according to the different kinds of work to be done; the next was to have a qualified foreman take direct charge of each class of work and have exclusive control of the work and the men assigned to him. The first and principal rule in the division was that all orders for work of any kind should be written out by the authorized officer in the department for which the work was to be done, and sent directly to the engineer in charge of the division. He would then issue his orders to the foremen, who in turn would direct the men in their work. The workmen were held directly responsible to their foreman for efficient and faithful work, and were forbidden to work for any one except as directed by the foreman. The foreman was held directly responsible to the head of the division for both materials and labor. Great patience and many explanations were required to put this system into effect.

The next point was to so divide the work that no conflict would occur between the city and the labor unions. This was safely got over in the majority of cases by having an understanding with these unions whereby the city could do emergency work, or even small jobs when no great amount of time or materials were required, by those who were best qualified to do it on the city forces; provided that no workmen of that particular class happened to be in the city's employ at the time.

Each foreman distributed his men as he considered best, but when several jobs were being looked after at one time, he was permitted to assign a "straw boss" to receive and give orders when two or more men were on the same job. When more work was being done than one foreman could properly care for, additional foremen were added. As the division performed all kinds of work that was turned over, we soon had a force that represented practically all the building trades: carpenters, painters, trimmers, roofers, masons, cement men, steam fitters, plumbers, gas-fitters, electricians, laborers, besides machinists, pattern-makers, blacksmiths, brass-molders, etc.

During the organization of these forces into an efficient working body, the present system of keeping accounts was evolved and put into operation. Every mechanic or laborer was given a printed time-slip, having the rules on the back. These were filled in each evening, showing name, kind of labor, time, etc., and sent to the foremen. The latter made out the regular job time sheet, and turned this over to the clerk in charge of the books. The foremen gave the name, occupation, hours, and cost of labor on each slip for each separate job. All orders for materials were made out on material blanks and turned in by the foremen to the clerk, who issued orders on the business agent or the stock-keeper. All slips for labor and materials were posted in the job register and then filed away in the job envelope for that particular piece of work. As each foreman completed his work he marked his order as completed, and gave it to the bookkeepers, who also filed these in job envelopes. When a job was completed, the sheets in the job record covering this work were turned over to the billing clerk. Warrants for collection were made out and sent to the department ordering the work, which department checked it and signed it if correct, and sent it back for payment. This method of giving a number to each order for work and keeping all records for labor, materials, etc., on each order in its particular envelope and properly filed, gives an accurate original record ready at all times for inspection and checking.

This system, which is entirely new for the city work, required an additional change for this particular division. Formerly each division of the city government had set aside enough funds to cover the different classes of materials and labor needed for the year's improvements in that division or bureau. In the construction and repair division, no appropriations are made for either labor or materials, but a working capital of $100,000 is set aside to cover this item, and this fund is reimbursed by warrants issued against the departments having work done. The working fund is thus left intact at the end of the year when all warrants are paid.

A small appropriation was made for machinery and alterations and new buildings, this being the only item of expense appropriated for in this division by the city council. As the division grew, the question of shops, machinery and storerooms became important. We have organized a good carpenter shop, tinner's shop and paint shop, together with suitable storage rooms for a large portion of the materials used. We soon found that our carpenter shop could turn out at a less cost and with better workmanship than could be secured from outside parties all odd-sized doors, window frames, sash, cabinets, cases, partitions, panel work, etc. In the tin shop we turn out skylights, gutters, downspouts, heavy galvanized iron pails, drip pans, oil cans, etc. All the work was so superior to the regular contract work done for the city that the quality of our work was never questioned. As an instance, in the water pipe extension division, on leaks and other work, they used the heaviest galvanized iron pails they could get in the open market. They paid some $6 per dozen, and used 70 to 100 dozen each year. The making of these pails was turned over to this division; they were made at a cost of about $10 per dozen, and 25 to 30 dozen filled the requirements. Although they cost more per pail, the year's saving on this item was fully half what was formerly paid.

When foremen were permitted to order materials, the city was not able to properly check the amounts ordered as compared with what actually went into the work, so an estimating engineer and architectural draftsmen were added to the division. The duty of the engineer was to look over work ordered and estimate the amount of materials and labor necessary. These estimates were filed in the office with the chief clerk, who checked requests for materials ordered by foremen by these estimates. Any large variations were called to the attention of the estimating engineer, who immediately investigated the same and reported. As a further check, when a job was finished the estimating engineer went over the work carefully and reported it as properly completed. With the architectural drafts-

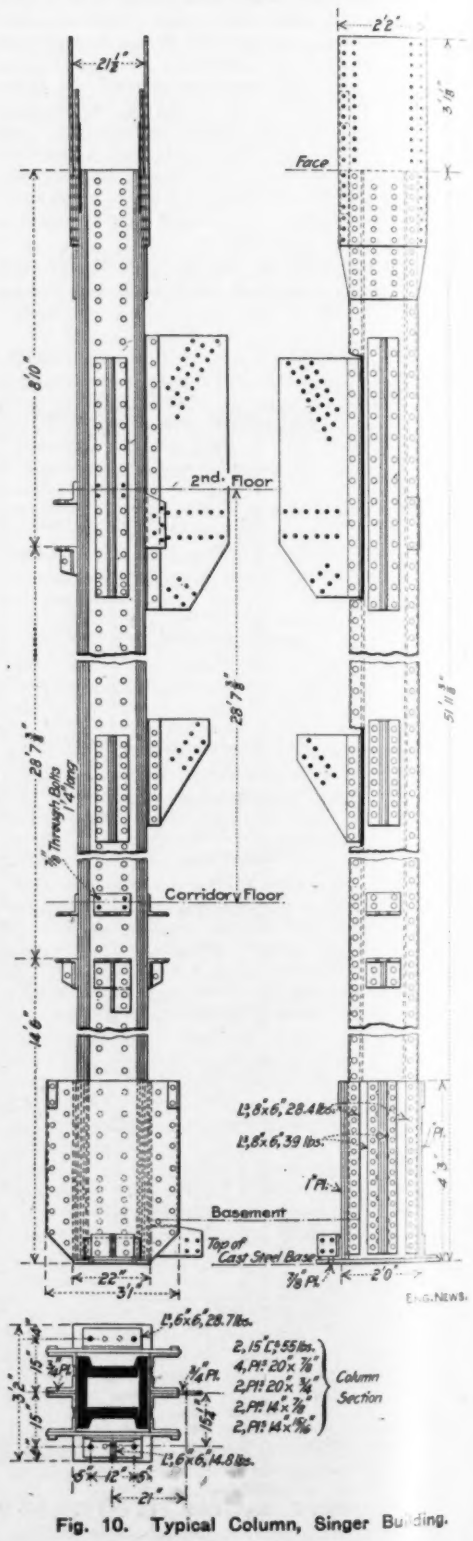


Fig. 10. Typical Column, Singer Building.

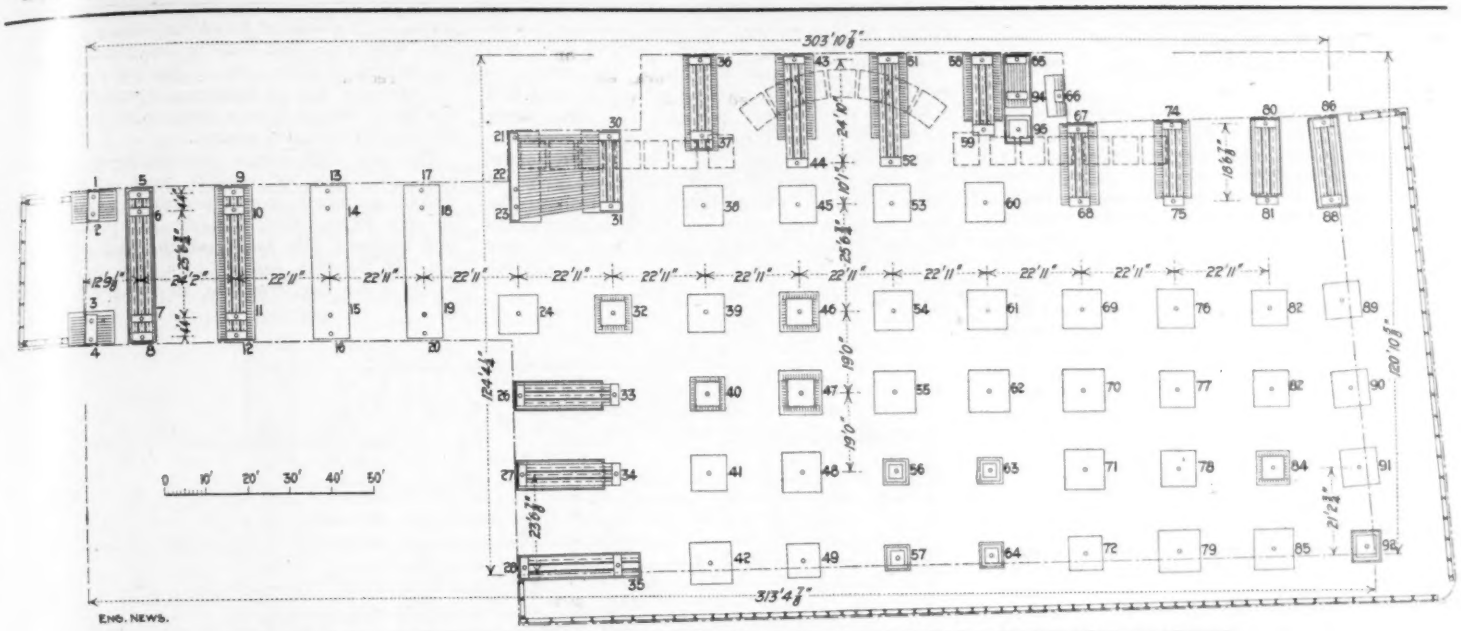


FIG. 11. CITY INVESTING BUILDING. FOUNDATION PLAN, WITH DETAILS OF COLUMN FOOTINGS.

men we were enabled to get out proper drawings of building alterations, etc., for use on work, and secure proper approval of the department ordering the work. During 1906 we performed work to the amount of some $400,000, while so far this year (1907) we have averaged some $40,000 per month. With our present organization the city can do much greater amounts of work with very little additional cost of operation.

As already stated, the city council appropriated only a small sum for new machinery and alterations. This fund, which was spent for machinery alterations and what new additions were granted us to make, was the sum total of our actual recognition before the finance committee. The cost of power, lights, stock keepers, wear and tear on machinery, telephones, clerical force, stationery, draftsmen, engineers, head of this division, office expenses, and all other items that enter into the cost of operation and cannot be charged directly to the jobs were covered by a 10% addition to the actual cost of labor and materials on each job. Last year the division came out some $7,100 ahead on this item, and this year the expectation is that even a greater surplus will be in our operation fund. Even in this item, although the money has been secured from funds devoted to construction and repair work, the city still holds this surplus and can devote it to any purpose. The intention is to cut the operation expense to 8 or 9%, according as experience may warrant.

It is the effort at all times to avoid laying off men or changing a well organized force. After a force is thoroughly organized and the men know that their work and position is permanent, better results can be secured in every way. The men have no excuse to loaf, as other jobs are waiting to be done as soon as the one they are on is finished. They have every desire to do their work well because they are aware that an accurate record is kept, showing names, occupation, dates and work done by each man. Imperfect work or high cost calls for an investigation that may cost them their position. Again, a complaint will be made by these men if first-class materials are not furnished on the work, so the workmanship, cost and quality of materials are factors that the workman and all concerned in the job are very anxious to see of the best, and in their favor. Good work, materials and low cost are practically all the points essential on public works. Each man gets his union scale of pay and is satisfied.

With contract work the results are the direct opposite. The job is taken with the intention of making money. Plans and specifications are prepared by the engineering bureau and the work let to the lowest bidder. This means competition on prices and every advantage is taken to secure the work. When the contract is let scheming may be commenced to clear as much as possible. In the worst cases, in spite of inspectors, engineers and others, the work is the cheapest possible, slighted in every way and brought up only to a standard where it will pass inspection by fair or unfair means. In such cases, the city gets poor work, poor materials, and as many extras as can be worked in.

Here is one point regarding the 10% operation expense on day labor work. Those doing the work, or the force representing what the contractor would have to employ, cover the whole cost of the job. But on contract work the city must have engineers, inspectors, draftsmen, etc., to keep track of what is going on. These represent as much or more than the actual cost of operation of a division doing the work directly

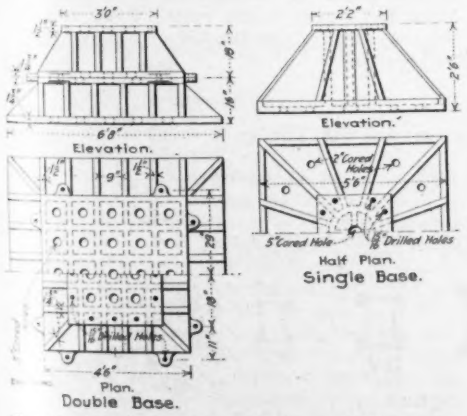


Fig. 12. Details of Cast Steel Bases of City Investing Building.

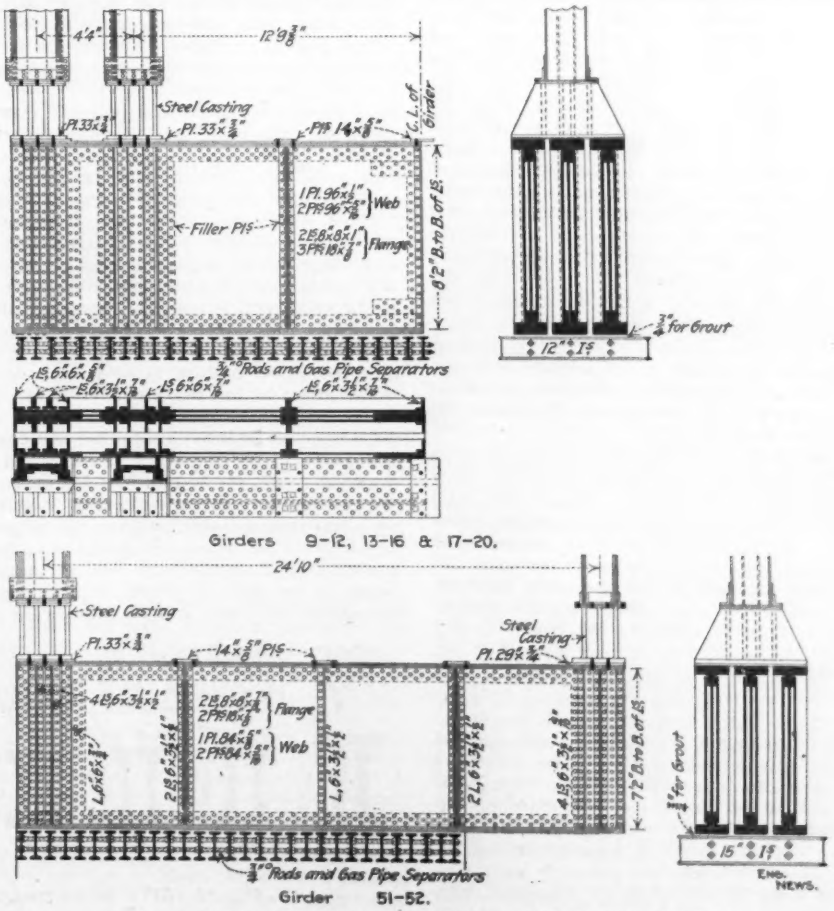


FIG. 13. CITY INVESTING BUILDING. FOUNDATION GIRDERS.

for the city. So in estimating the cost of contract work we have cost of contract as let with extras, plus the engineering expense added to this amount.

By city day labor, or having work done by a construction and repair division, "graft" is practically eliminated, for the following reasons: (1) No money is handled in any way outside of pay checks that go for actual labor done; (2) No materials are purchased by the division; they are secured by contract or through the purchasing agent on competitive bids and sent to the division; (3) The department having work done usually has a person on watch who receipts for labor and materials delivered so that the department head can intelligently endorse the warrant for collection, when it comes through; (4) The estimating engineer also thoroughly inspects all work; (5) The foremen and laborers note

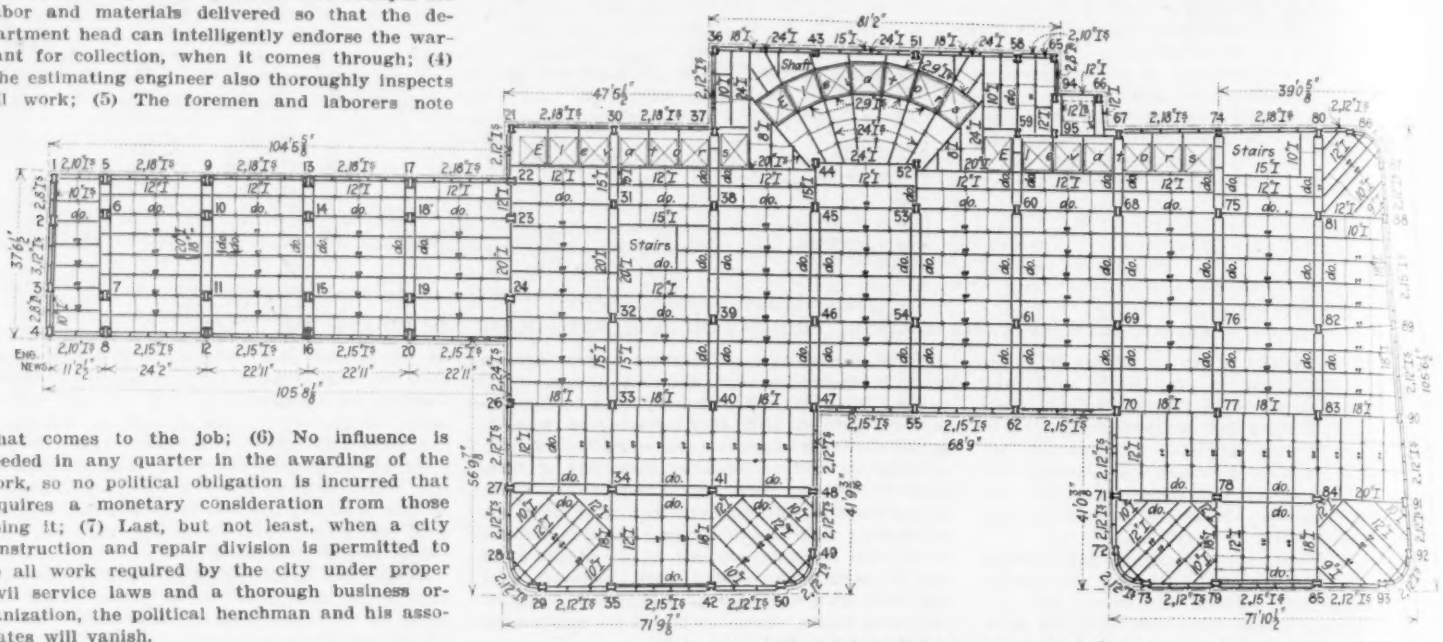


FIG. 14. TYPICAL FLOOR PLAN ABOVE THIRD FLOOR OF CITY INVESTING BUILDING.

what comes to the job; (6) No influence is needed in any quarter in the awarding of the work, so no political obligation is incurred that requires a monetary consideration from those doing it; (7) Last, but not least, when a city construction and repair division is permitted to do all work required by the city under proper civil service laws and a thorough business organization, the political henchman and his associates will vanish.

We will now turn to machine shop work. When the shop was turned over to this division, we had some 75 men working in crowded quarters with old machinery and the poorest system of handling heavy materials. Piles of old iron and other materials were lying around, and everything had a neglected appearance. The lathes and other machines were were run at very slow speed, and there were not sufficient electric lights for cloudy days. The first orders were to clean up the place and have the business agent dispose of all old iron and other materials that could not be used. The power and lighting plant was thoroughly overhauled and the speed of machinery increased fully 35%. A roof over an air shaft in the center of the shop was replaced with a skylight about 28 × 40 ft., and this improvement cut out the need of electric lights except in winter and very dark days. The machinery was overhauled and several new machines were ordered, among which was a new 1,100-lb. steam hammer for the blacksmith shop. This hammer alone nearly doubles the capacity of the shop. A system of pneumatic hoists and runways was laid out, and when this is installed it will greatly facilitate the handling of materials.

So much trouble was experienced in the contracts for brass castings that we were permitted to establish a brass foundry. We started with one molder and one furnace man or helper, which force has been increased to four molders and two helpers, coremakers, etc. The results obtained in this foundry illustrate what could be accomplished in an iron foundry should the city ever feel a desire to save some 30 or 40% on iron castings. We found that our old method of letting contracts for brass castings threw all castings of this material into one grade. This secured for the city a poor make-shift for its requirements, as some 30 to 35% were rejected either on their receipt or after flaws developed when put on the lathe. By making castings in our own foundry we mixed our materials to make metal suitable for the requirements, and now turn out gun metal or phosphor-bronze as needed, as our molders are supplied with formulas for some 70 or 80 different mixtures. The results of this method are that we have no rejected castings, and no lathe work is done that is lost owing to poor materials. The saving on machine work alone means a saving of some 60% over the old contract system. The scrap brass we receive is run through a magnetic separator that thoroughly cleans it. This means cleaner and more uniform castings, free from lumps of foreign matter which injure the tools. The lathe tools on this work run three or four times as long without being sharpened and with this saving alone the city should feel well repaid for the small layout for this foundry.

But this represents only a part of the saving to the city. Contract work means that the foundry will turn out castings as heavy as will pass inspection. Any changes in patterns and repairs on same means delays and more or less annoyance when they are made by outside parties. When the city started to make its own brass castings we soon became aware of the fact that new patterns were needed for nearly every piece. By cutting off corners and reducing sizes in accordance with what was required for strength, we soon found that we could get better results and save some 10% to 20% on the weight of metal. In some cases even a greater saving was secured. This also opened up a new field for the city to dispose of all its old brass, copper and other similar materials used in brass foundry. This year we have purchased some $10,000 worth of copper, brass, etc., from the other departments that was formerly sold for scrap. One of the great items of cost that formerly entered into the brass casting problem was delays on work caused by not being able to get all the different castings as required. This delay was always a source of great annoyance and cost. The city saves in the following ways by doing this work for itself: (1) It gets castings of a suitable composition for what is needed; (2) It gets pound price less than suitable castings can be furnished by contract or when purchased on the open market; (3) It saves some 60% on lathe work owing to the fact of having no poor materials, no rejected castings, and no lathe work thrown away on account of flaws developing. [illegible] also less wear and tear in machinery [illegible] sharpening of tools. (4) It gets lighter [illegible] ter castings, due to cutting out surplu[illegible] (5) There are no delays on account of [illegible] able to get parts as needed.

This not only means cheapening cos[illegible] shop, but also on outside work of [illegible] valves, hydrants, and other materials [illegible] on city work. The contract for misc[illegible] iron castings this year cost the city $[illegible] ton. If the city ran its own iron fou[illegible] could easily cut this cost to some $30 [illegible]

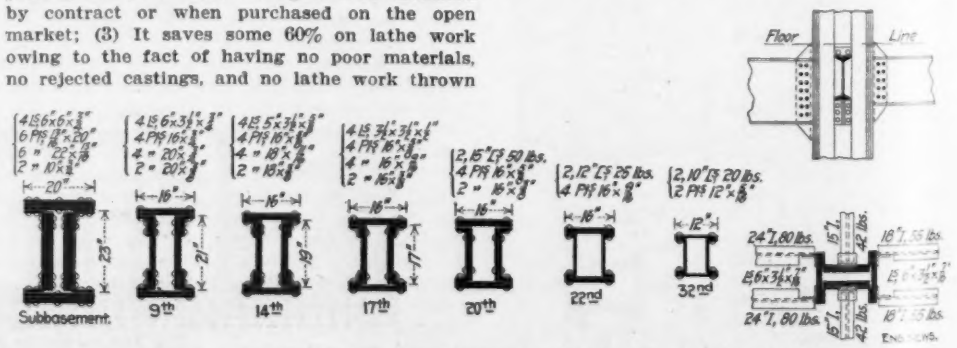


FIG. 15. CITY INVESTING BUILDING. TYPICAL COLUMN SECTIONS.

per ton, and use some 150 to 300 tons of scrap iron sold to outside parties each year. Suitable metal for castings and all points that are given above for the brass foundry apply equally as well for the iron castings.

The establishment of a municipal iron foundry was considered by the city about a year ago. The contract work for 1906 for the water department alone (including hydrant rings and covers, valve covers, and special hydrant and valve castings) amounted to over $30,000. The report estimated that the city could do the work at about the same price, but with better results and obtain material better fitted for the various purposes. This is exclusive of the castings for the street, sewer, bridge, electrical, fire, police and other departments. The plan was to establish this in connection with the present plant at 22d St. and Ashland Ave. Adjacent to that point the city already has a pumping station (soon to be abandoned for a new station on another site) percentage of rejected castings, as has been and a police department repair shop. The buildings of these three plants could easily be adapted to form one large central municipal plant, the present plant at Michigan Ave. and 14th St. being also moved to this point. Under this plan the city would utilize the 150 to 300 tons of pipe

and scrap now sold for old metal, it would be free from the delays due to contractors being already crowded with other orders, and there would be an incentive to economize in weight rather than to increase the weight of castings. At the same time there would probably be a much smaller found to be the case with the brass castings now made by the city. A committee of the Labor and Trades Union which investigated the matter, gave a total cost of $60,380 for a municipal iron foundry (including buildings, plant, labor, operation, taxes, repairs, etc.). With a capacity of 2,000 tons per year, the average cost of castings would be a little over $30 per ton. The average for contract work was $36 per ton in 1906 and $59.74 in 1907.

One of the greatest errors and items of shortsightedness that is costing the city a great deal of money is well illustrated in the following examples. The police, fire and water departments, street bureau, and school board each has a separate organization for carrying on shop and city work. The Police Department shop just south of the water-works shop at 22d St. and Ashland Ave. has more space than the water-works shops and uses about one-third as many men to do the work. The duplication of machinery is costly, especially when in one shop it is lying idle while in the other it is impossible to turn out the work as needed owing to an insufficient number of machines. The cost of maintaining separate organizations for each department is high, especially when it is considered that all work needed by the city could be done better and in a more systematic way by placing it under one head, or management. Organization, systematizing and concentration of forces means economy in cost of work, labor and materials and operating expense.

Another item that should be mentioned is the method used by the city in the purchase of materials. At present it goes on the open market and buys a few barrels of lime, a few yards of sand, or small quantities of cement, nails, and all other items used by the city in small lots but in great aggregate quantities. It should have suitable storehouses, and purchase these items in the open market in large shipments. I have demonstrated enough of the problems and facts to enable the people of this city at least to take the question of municipal improvements and work in hand and solve it on an economic and business basis the same as any large private corporation would solve problems pertaining to its needs.

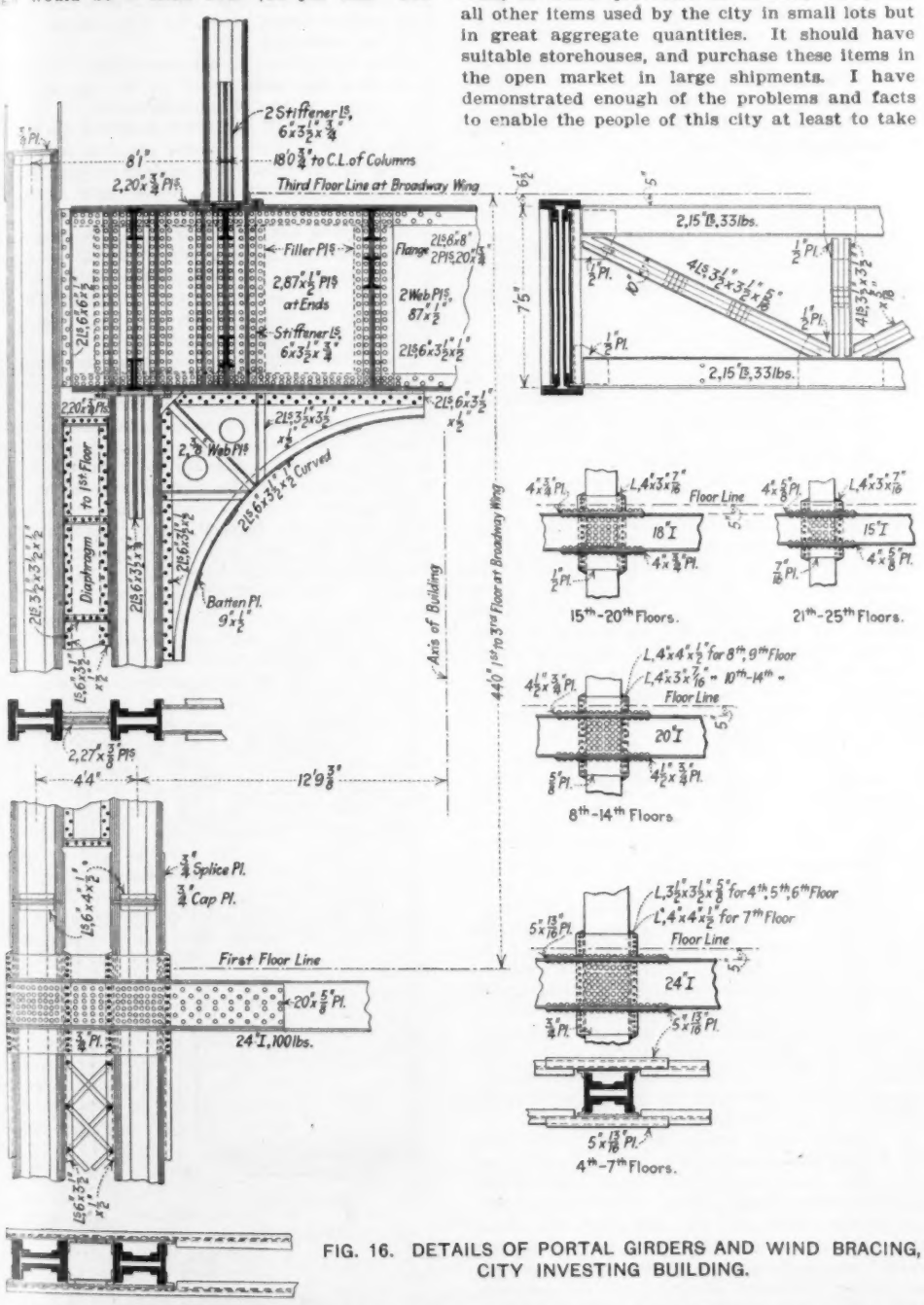


FIG. 16. DETAILS OF PORTAL GIRDERS AND WIND BRACING, CITY INVESTING BUILDING.

THE TURBINE DESTROYER TARTAR, one of the new class of 33-knot turbine destroyers, recently completed for the British navy by John I. Thornycroft & Co., Southampton, recently ran a successful contractors' trial. This was briefly described in "The Engineer" of Nov. 22. The mean speed of six runs was 33.122 knots and without vibration. The power is produced by turbines arranged on three shafts and developing approximately 14,000 I. HP. The high-pressure turbine on the center shaft exhausts into the low-pressure turbines on the wing shafts. Forward of the low-pressure turbines is a high-pressure and low pressure cruising turbine, each driving a shaft with one propeller. Steam is supplied by six water-tube boilers of the latest Admiralty type, using oil fuel exclusively, and work at 220 lbs. per sq. in. Though the vessel is of greater beam than others of the same class, the speed is the greatest yet obtained by any of the 33-knot boats on contractors' preliminary trials. There is likelihood that this speed may be exceeded. The Tartar is 270 ft. on water-line in length, 26 ft. in width, and 17 ft. 2 in. in depth. Her shape follows generally the lines of the earlier destroyers by the same firm, a prominent feature of which is the turtle deck instead of the raised forecastle deck generally adopted for vessels of this size. The advantages claimed for the former is that the water is thrown overboard instead of under the upper deck. The Tartar has also considerably greater freeboard than the other 33-knot vessels now being built.

EXPERIMENTS WITH ELECTRICAL TREATMENT OF BOILER WATER ON THE EL PASO & SOUTHWESTERN RAILWAY SYSTEM.*

By J. L. CAMPBELL.†

The worst wells on our road are east of El Paso. After we have treated these exceptionally bad waters, which cover a distance of 128 miles on the Eastern Division, they are still of bad quality, and as a result our engine tonnage is reduced 25% and the excess annual maintenance on locomotives is approximately $1,000 per year per engine. Generally we cannot reduce the incrusting solids in these bad waters below 20 grains per gal. without producing an inadmissible amount of foaming; consequently, we have exhausted the practicability of the lime and soda ash treatment.

During the past year we have been experimenting with the electrical treatment of some of these waters. At Alamogordo we reduced the incrusting solids from 40 grains to an average of 6 grains per gal., and at Pastura from 140 to 30 grains. It was possible to still further reduce the Pastura water by increasing the intensity of the electric current and the time of treatment, but we have ascertained that the electrical treatment is impracticable on account of the excessive cost, which has run as high as $1 per 1,000 gals. for the worst waters if treated down to 10 grains and less per gal.

The method of treatment consisted in submerging aluminum or iron plates in the water to be treated and passing an electric current through the plates, which were suitably connected up in series. The experimental treating plants consist of a series of wooden vats, each of which is divided into a number of compartments, each compartment containing a large number of aluminum or iron plates set on edge in grooves and spaced from ½ in. to 1 in. apart. In one of the plants the water flowed continuously by gravity through the vats. In the other the vats were filled and the water remained stationary until treated, when it was emptied and the vat refilled. For a number of reasons the intermittent treatment would probably be the more practicable in continued use. The aluminum plates experimented with were about 12 ins. wide and 3 ft. long; the iron plates are about 3 ft. square. Both kinds of plates are dissolved in proportion to the amount of water treated, and we find the expense of the renewal of plates is a very large item in the cost of treatment. As a result of the experiments, our conclusions are that the electrical treatment is not practicable on account of the cost and the large amount of work involved in the daily operation, cleaning and maintenance of the experimental plant.

On the division of the road above specified, where the waters are so bad for a distance of 128 miles, we have adopted a very radical remedy, which consists of bringing water by gravity from the White Mountains to and along our railway for a distance of 130 miles by means of a combined gravity pipe line and two pumping plants to lift the water over a divide between the Rio Grande and the Rio Pecos drainage areas. The water from the White Mountains is of a very superior quality, averaging about 5 grains incrusting solids per gal. This pipe line will eliminate all of the present water supply, which cannot be successfully treated with lime and soda ash; in fact, it will eliminate all of the treating plants we now have, with one exception. The estimated cost of this supply of pure mountain water is $1,300,000, but we find that its capitalized value will be several times that amount, from which the seriousness of the water condition in the past can be judged.

Our present water supply in question has an annual charge against it of 98 cts. per 1,000 gals., which includes charges for reduced train tonnage, the excess annual repairs to locomotives and incidental impairment to the efficiency of the service generally. We estimate that the pipe line supply of water will carry an annual charge of 16 cts. per 1,000 gals.

*Abstract of a paper in Bulletin No. 91 of the American Railway Engineering and Maintenance of Way Association: Secretary, E. H. Fritch, 962 Monadnock Block, Chicago.

†Engineer of Maintenance of Way, El Paso & Southwestern Ry., El Paso, Tex.

REPORT OF THE TRANSVAAL COMMISSION ON THE USE OF WINDING ROPES, SAFETY CATCHES AND APPLIANCES IN MINE SHAFTS.

(*Concluded from our last issue, page 549.*)

Tests of Safety Catches.

We have published the complete report of the Commission in our issues of Oct. 31 to Nov. 21. In the volume in which it was originally published, the report proper occupied 34 pages of a pamphlet 8 × 13 ins.; while the supplementary information—descriptions of apparatus, details of tests, cuts, etc.—were arranged after the report proper in a "schedule of annexures" covering 75 pages.

The arrangement of the data and results of the various experiments, in this "schedule of annexures," is chronological instead of according to devices, and hard to follow; the matter is also very voluminous. We have therefore made the following abstract of the tests on the principal devices, considerably condensing the details.

THE MARCUS SHAFT.

Preliminary to a description of the tests of safety catches covered by paragraphs 143 to 170, inclusive, of the report, some idea should be given of the Marcus shaft of the Langlaagte Estate and Gold Mining Co., where the tests were conducted, and of its equipment.

It is a 3-compartment shaft, with one compartment for pumps and ladders and two for hoisting. The depth is 597 ft., and the shaft is timbered with 8 × 8-in. pitch-pine sets. Fig. 1 shows a plan of the collar set, with the 4 × 4-in. pitch-pine guides.

The headgear, or gallows frame as it is called in this country, is of steel, 33 ft. high and fitted with 8-ft. sheaves. The height from the collar of the shaft to the overwinding attaching plate is 27 ft. 5 ins.

The hoisting engine is of the double-cylinder geared drum type, with 18-in. cylinders and 28-in. stroke, working at a steam pressure of 90 lbs.

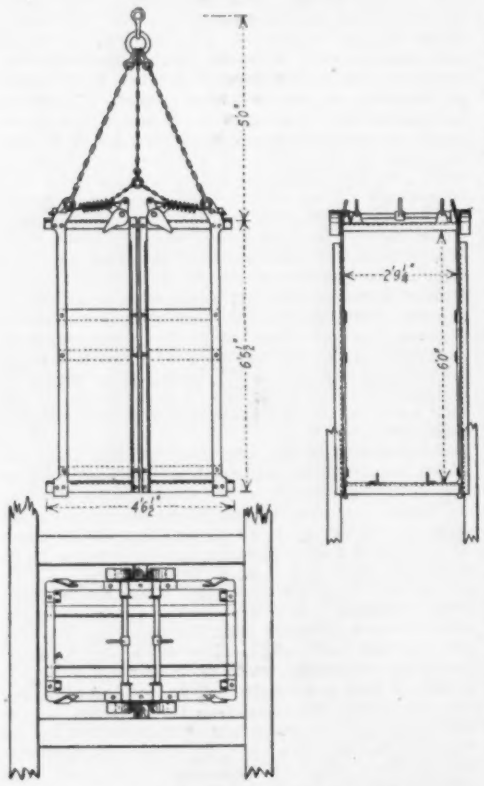


Fig. 2. Type of Cage Employed at the Marcus Shaft, Transvaal, as Originally Used.

(The heels or stops on the cam shafts were added after the first experiments. The catches shown here are of the White & Grant type.)

The drums are 8 ft. in diameter, and the gear reduction is 1:3.7. During the tests a tachometer was fitted to the drum shaft, to indicate the speed of hoisting.

Fig. 2 shows one of the cages used in the experiments. They are designed to carry a car containing 1 ton of material, and are fitted with the ordinary eccentric toothed-cam, spring-actuated safety catches of the White & Grant type*—somewhat similar to those used in this country—which the springs cause to bite the guides upon the detachment of the rope and which the weight of the cage tends to force into still closer engagement. The "heels" or stops, on the shafts carrying these cams (see plan and side elevation, Fig. 1) were added after the first experiment. The teeth of these cams on the Marcus

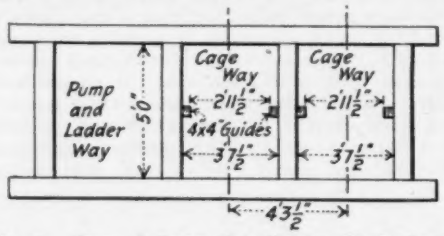


Fig. 1. Plan of Collar Set, Marcus Shaft, Langlaagte Estates & Gold-Mining Co., Transvaal.

shaft cages, it should be mentioned, had been "completely worn away by use, on the greater part of the cam." The detaching hook used was of the King-Humble pattern.

DETAILS OF TESTS.

FIRST TEST.—This test was made simply to try out the ordinary safety devices already on the Marcus shaft cages. In the first experiments, with the cage empty (the ordinary cage, with no especial preparation of any kind) it was intentionally overwound—hoisted slowly from the surface to the sheave. The detaching hook worked satisfactorily, freeing the rope and leaving the cage apparently hanging from the plate by the detaching hook; on closer inspection, however, it was seen that the chains were slack and that the safety catches were holding the cage—three cams having taken hold. This is worthy of note, because the King-Humble hook allows the cage to drop about 2½ ins. after detaching the rope before the wings, which project to hold the cage, come into action; the promptness of the operation of the White & Grant safety catches is shown up very clearly

In the second set of experiments, various conditions were imposed with the cage both empty and loaded. It should be said here that the empty cage weighed 1,700 lbs'; and that the rope, a round one, was 1⅛ in. in diameter; also that the aggregate strength of the springs operating the safety-catch cams was 815 lbs.

A spring balance was suspended in the cage, to determine the amount of shock at the stoppage of the cage. In one trial, with 67 lbs. hung from the spring balance and the cage released from rest, the balance registered a shock of 300 lbs. The cams gripped immediately and did no damage to the guides. In another trial, with 150 lbs. on the balance and the empty cage dropped with 3 ft. of initial downward start, the balance broke loose and the guides were badly amaged by the cams when they took hold.

In a similar trial where the cage, loaded with about 3,000 lbs., was dropped with 3 ft. of initial start, the cams cut enough timber out of the guides to allow them to turn completely around; and at the same time the cam shaft was bent. The cage, after a momentary check (during which time the damage was done) fell freely until caught by the stops at the shaft collar—these trials being made above ground, in the frame.

Means were provided, to give the 3-ft. start before the cams should operate, for holding the cams from operating by means of a chain and clip, released after a 3-ft. drop.

The "heels" shown on the cams, in Fig. 2, were attached after these trials to ascertain their value in preventing the complete turning of the cams, the same cage being used. While the guides were cut into by the cams, from ½-in. to 1 in., the catches acted satisfactorily in the above-ground trials.

In a further trial, the cage descending in the shaft at about 1,700 ft. per min. when released, and carrying a 3,000-lb. load, the cage fell over 40 ft. before it was caught; and it was thrown to a horizontal position across the shaft, the catches seeming to have acted violently and breaking the guide completely on one side.

The resultant of all of these trials of the White & Grant catch was, as is stated in paragraph 161 of the report, to prove the catch unreliable.

TESTS OF THE HUGHES SAFETY CATCH.*—Briefly, this consists of shafts fixed across the top of the cage, to which are attached the eccentrics. Connected to the eccentrics are two levers with retarding shoes attached. When the rope breaks the eccentric shafts act, and upon the cams coming into contact with the guides "an infinite stress is set up between the guides and the retarding shoes."

Four preliminary trials were made of this device, and five subsequent trials. As stated in the report, it proved unsatisfactory.

TESTS OF THE GARVIN SAFETY CATCH.—This device is shown in the drawing reproduced in Fig. 3. It consists of wedges at each side of the guides, having ⅜-in. teeth ½-in. apart on their acting faces. These wedges are forced into action, when the rope breaks, by being pushed upward by the forked ends of a pair of toggle levers, operated by the springs shown in the drawing. The device of itself weighs 1,690 lbs. As shown in the drawing, it is attached to a bucket instead of a cage.

A considerable number of tests were made of this device; first in the form shown, and subsequently with various alterations. The stops shown directly above the wedges were added after the first trial, and were lengthened by 1 in. after the second; a still further reduction of ¼-in. in the travel of the wedges was made later. After the first trial the number and width of the teeth were twice reduced, with considerable reduction in the wear and tear on the guides.

With loads varying from 800 lbs. to 2,800 lbs. (making, with the 1,500 lbs. of the cage and

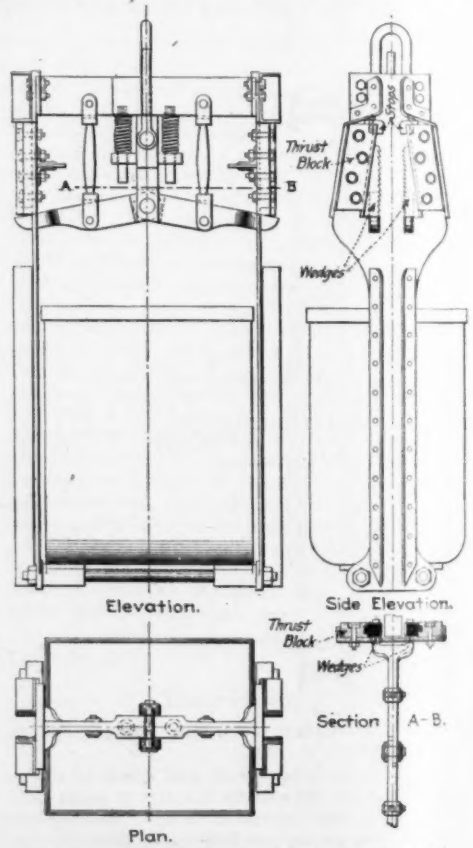


Fig. 3. Diagram of the Garvin Safety Catch.

1,690 lbs. of the device itself, totals of about 4,000 lbs. to 6,000 lbs.) and various conditions of dropping—similar to those imposed in the tests of the ordinary devices on the cage—tests were conducted on a number of occasions during a period of a year, and with the different alterations which we have already noted.

*See paragraph 161 of report.

*See paragraph 165 of report.

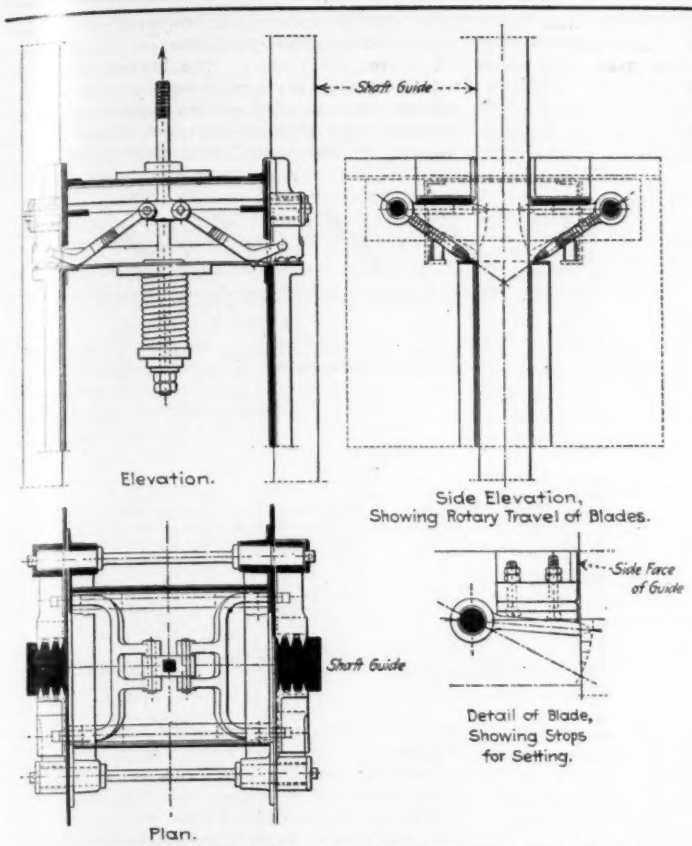


FIG. 4. DIAGRAM OF PROF. UNDEUTSCH'S SAFETY CATCH.

(The solid-black portions of the plan view are the guides, with the blades embedded. The small sketch at the lower right shows the means of adjusting the depth of penetration of the blades.)

Without going at length into the details of these tests we may say that the principal objections which characterized the Garvin device were its suddenness of stopping action, with attendant shock to the cage and its load (a serious consideration where the load may be men) and its effect in damaging the guides. In tests where the cage would be caught and held positively—in some cases with a preliminary downward run at high speed—the wedges would always be driven home to the stops, and the teeth well into the guides.

In one case a downward run of 414 ft. per min. was given, and the rope—552 ft. long—disconnected with the cage falling at 2,500 ft. per min. as registered at the tachometer on the engine. Although the teeth on the wedges penetrated the guides ⅛-in. all the way down, after disconnection, the cage and its load, totaling 4,000 lbs., were not held and fell clear to the penthouse which had been erected in the shaft.

On the whole, then, the Garvin device did not prove satisfactory under the tests. The fact that the Commission continued the tests for a year, however, is worthy of note.

TESTS OF THE THOMSON SAFETY CATCH.—This device consists of two pairs of flat brake shoes, 10 x 2½ ins., which, when brought into action by means of a vertical lever arm hinged to back of each shoe, exert a gradually increasing pressure on the sides of the guides. In each lever is a long slot in which works a roller, ¾-in. in diameter, forming the axle of a pair of large rollers 6 ins. in diameter which bear against the side of a guide when the catch is brought into action. The large roller thus revolves, and in doing so travels upwards along the slot in the lever—the slot being set at an angle with the shaft guide, so that as the roller travels along it the lever arm is forced outwards and presses the brake shoes into engagement. The device weighs 420 lbs.

Tests were made on this catch on two occasions. After the first trial, a rack was cut in one face of each of the slots and pinions running therein substituted for the small rollers, to ensure the travel of the large rollers up the slot when set in rotation by contact with the shaft guides.

Briefly, the device failed to hold the loaded cage (4,000 lbs. total) in any trial, the rope loosened from a position of rest. In none of the trials, even after the racks and pinions were fitted to ensure the travel of the shafts of the rollers up the inclined slots, did the brake shoes exert sufficient pressure on the shaft guides to produce satisfactory operation.

TESTS OF THE UNDEUTSCH* SAFETY CATCH.—A drawing of Prof. Undeutsch's device is shown in Fig. 4. To quote from a letter of his written to the Commission on Jan. 6, 1906:

The author has based his safety catch on the principles of the simple brake used with children's sledges, and on the position of a man climbing up or down two poles. The main principles which underlie the design of his brake are simple and narrow arms or catches, which should be indestructible, whose penetration into wooden guides should be limited and which should have knife or chisel edges.

The shock to persons is reduced to a minimum, and is then not dangerous. It is independent of the height of free fall, i. e., of the square of the final velocity, whatever the speed of descent of the cage after the rope breaks might be.

The relation of these retarding knife edges to the guides is shown in the plan and side elevation in the drawing. The edges are parallel to the length of the shaft guides, and there are 12 in all—3 on each side of each guide. These edges are 1 3-16 ins. long.

While the heavy spring shown starts the braking edges into action, it is the descending weight which forces them into the wood until they are horizontal and bear against the stops as shown. The spring is no longer necessary, as an operating agent, after the noses of the blades have reached the point where they catch the wood of the guides.

A small upward movement of the drawbar of the cage (such as might be caused if a length of rope were following the falling cage and became momentarily caught) will not cause the withdrawal of the blades. Only a fresh connection of the rope to the cage, and the raising of the latter, will do this—a point in which Prof. Undeutsch's catch differs from all others. This device weighs 895 lbs.

Prof. Undeutsch has devoted much study to the subject of mine hoisting and its attendant dangers.* A further quotation from his letter, previously mentioned, may be of interest.

The writer was one of the first, at the time of the German Exhibition at Berlin in 1889 for the prevention of accidents, to point out that the dangerous portion of the hoisting rope was not near the sheave, as was then generally accepted, but was in the immediate neighborhood of the cage itself, both due to shock and to rusting and corrosion produced by acid mine water.

The results of a number of experiments on the latter subject were published by the author in the "Oesterreichischen Zeitschrift fur Berg—und Huttenwesen," 1892, and in a pamphlet entitled "Strains of Suspended Prismatic Bodies Due to Static and Dynamic Stresses."

The indicator used by the writer not only registered the shock to which the rope was exposed, but also the actual length of the portion exposed to the shock.

The conclusion arrived at from the foregoing is that taper ropes are undesirable, although, considered statically, they present some advantages. Prismatic (cylindrical) ropes are distinctly safer and stronger at their lower ends. As there are thus some objections to the use of taper ropes for great depths and heavy loads, the writer would suggest the use of electric hoists and stage winding.

The data on which the writer has based the majority of his experiments and deductions were derived from the rope statistics gathered by the Mines Department at Dortmund and Breslau, on the initiative of Bergrat Hiltrop and by the Freiberg Mines Department, at the writer's own suggestion.

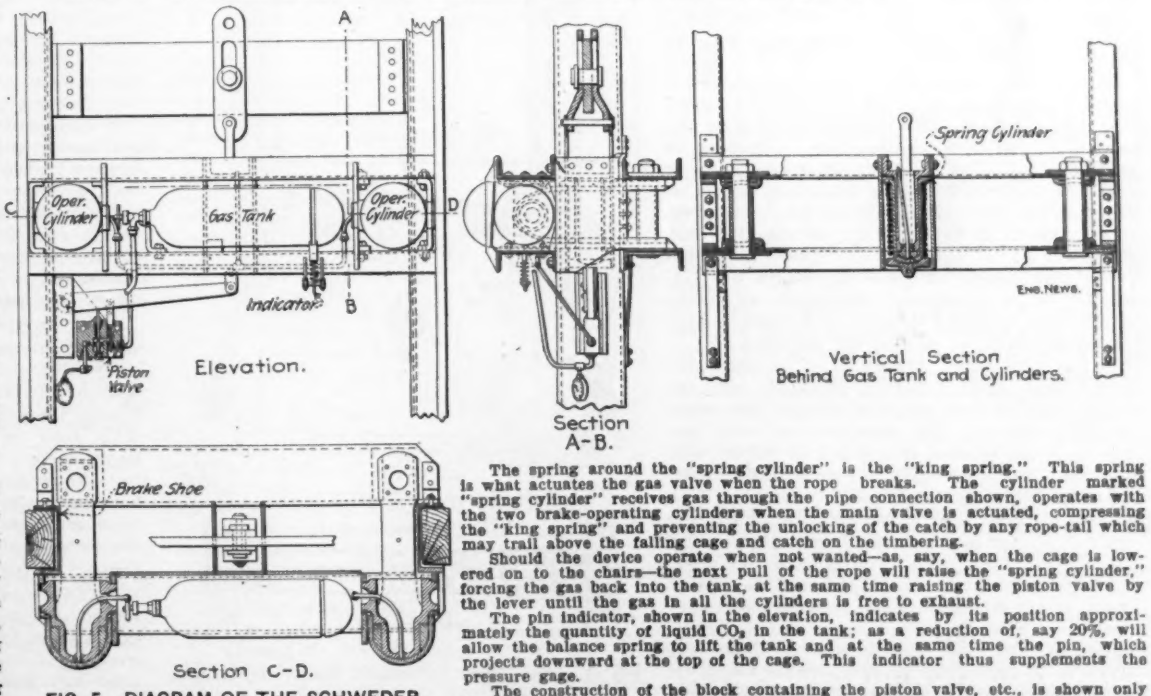


FIG. 5. DIAGRAM OF THE SCHWEDER SAFETY CATCH.

The spring around the "spring cylinder" is the "king spring." This spring is what actuates the gas valve when the rope breaks. The cylinder marked "spring cylinder" receives gas through the pipe connection shown, operates with the two brake-operating cylinders when the main valve is actuated, compressing the "king spring" and preventing the unlocking of the catch by any rope-tail which may trail above the falling cage and catch on the timbering.

Should the device operate when not wanted—as, say, when the cage is lowered on to the chairs—the next pull of the rope will raise the "spring cylinder," forcing the gas back into the tank, at the same time raising the piston valve by the lever until the gas in all the cylinders is free to exhaust.

The pin indicator, shown in the elevation, indicates by its position approximately the quantity of liquid CO_2 in the tank; as a reduction of, say 20%, will allow the balance spring to lift the tank and at the same time the pin, which projects downward at the top of the cage. This indicator thus supplements the pressure gage.

The construction of the block containing the piston valve, etc., is shown only diagrammatically here, as the sketch available for reproduction was obscure and blurred.

The introduction of speed safeties to prevent overwinding may be looked upon as a direct result of the

*Prof. H. Undeutsch, Freiberg, Saxony.

*The results of Prof. Undeutsch's experiments were published in pamphlet form in 1889, under the title "Experimental Proofs of the Dangerous Action to which Persons and Cages are Exposed on the Breaking of Hoisting Ropes" (Craz & Gerlach, Freiberg).

Freiberg statistics, for Prof. Menzner of Freiberg proved that in the period from 1884 to 1891, among 101 cases of breakage of ropes and chains, 20 accidents were directly due to overwinding of the cage against the sheave. A special inducement for the perfection of speed safeties was the offer of a prize by the Freiberg Mines Department.

The information concerning ropes, gathered by the Dortmund Mines Department, has been shown graphically by the writer on page 225 of his book. At the time, in 1871, when Hiltrop and the Dortmund Mines Department started, the keeping of rope records and the development of safety catches was in its infancy. At that time, and with the introduction of the older form of safety catch, it was generally accepted that the rope attached to the ascending heavy cage was the one most liable to break. The problem at that time, therefore, was merely catching the ascending cage from rest, so to speak.

The original views have long ago been proved to be fallacious in that, as often as not, it is the rapidly moving descending rope which breaks. The older safety catches in the latter case gave rise to tremendous shock to descending persons, and enormous damage to the cage and to the shaft timbering. These consequences gave rise to the deep distrust in safety catches evinced for some time by the Dortmund Mines Department and by experts. This led to the saying that "a good rope is the best safety catch."

Mr. von Sparre, of Dortmund, drew the writer's attention to the rope statistics gathered, and suggested that, in addition to the safety of good ropes, there would be additional security if the safety catches could be improved, particularly in the direction of their not only catching the ascending but also the descending cage with a minimum amount of shock.

With this object in view, the writer, 30 years ago, began his investigations and experiments with slender knife- and chisel-edge catches the reduction to a minimum of the shock on catching and braking; and later, also, his free-fall catch and indicator experiments, the invention of the shock measurer (energy indicator) and the regulation of the size and shape of the arms and catches to meet different conditions. The result of his labors is shown in the latest design as shown in the accompanying drawing.

The Commission tested the Undeutsch catch in June, 1906, and March, 1907. In the first trials the blades were adjusted for a maximum penetration of 1 in., the guides being 4½ ins. in width and of pitch pine. With the empty cage slipped from rest in the head frame, the cage and safety catch together weighing 2,400 lbs., the cage was stopped after a drop of only ⅞-in., the average penetration of the 12 blades being but 9/32 in. With a load of 1,600 lbs. added, and a permitted initial drop of 3 ft., the cage dropped less than a foot farther; not all of the blades penetrated, owing to the canting of the cage; but they held, and with small shock.

Altering the adjustment to give the blades but ½-in. penetration, the cage was given a sharp run down of 30 ft. with the same load as in the preceding, and then disconnected. It dropped 48 ft. 6 ins., including the 30-ft. start, and came to rest, the blades all having come into action at once after a total drop of 36 ft., and having required about 13 ft. in which to stop the fall. (This should be noted in particular, in that—given positiveness of operation, which the Undeutsch catch undoubtedly displayed—an extension of the stopping action of a safety catch minimizes shock to persons on the cage.)

In the tests nearly a year later, on pitch-pine guides worn down to about 3¾ × 3¾ ins., the blades were set so as to penetrate until the points were 2 ins. apart. The cage was run down rapidly from the surface to a depth of 400 ft., and the rope was disconnected automatically from the drum. The cage, with 480 ft. of rope, was brought to rest after a fall of only 30 ft.; the velocity at the instant of disconnection being about 2,500 ft. per min. No damage was done, save that the knife edges entered the guides about ½-in. on each side, scoring out that amount of timber.

The results of these trials proved the Undeutsch device to be thoroughly reliable, simple and positive in its operation, and free from the objections of shock and damage to guides.

TESTS OF THE SCHWEDER* SAFETY CATCH.—The unique feature of this catch, shown in Fig. 5 without any attached cage, is that it is operated by carbonic acid gas at a pressure of 800 lbs. per sq. in., carried in a cylinder on the top of the gear. Upon the breakage of the rope, a spring actuates a lever which opens a valve and admits the gas to two 4-in. cylinders, placed close to the shaft guides. The inner cylinders, within these, are forced out by the pressure and drive brake shoes directly against the guides.

*K. Schweder, Acting Consulting Mechanical Engineer, A. Goerz & Co., Ltd., Johannesburg.

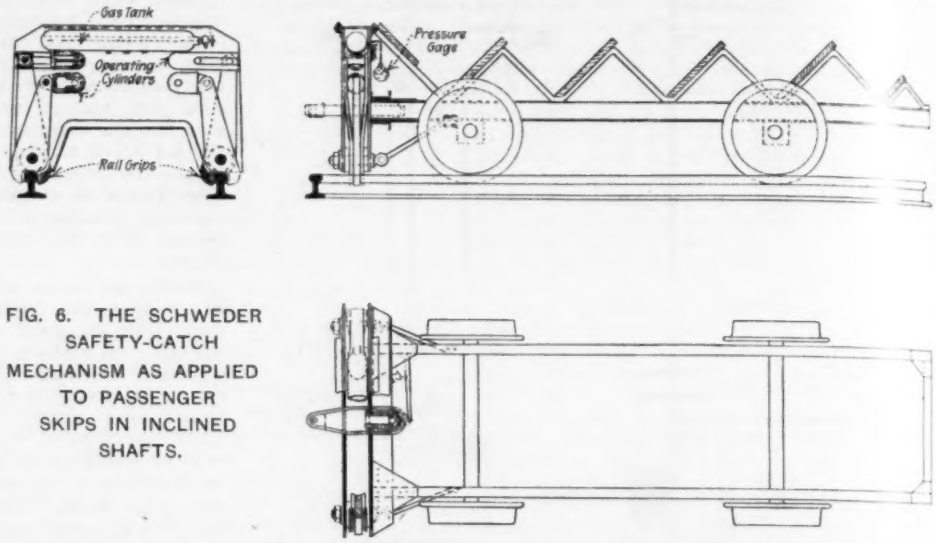


FIG. 6. THE SCHWEDER SAFETY-CATCH MECHANISM AS APPLIED TO PASSENGER SKIPS IN INCLINED SHAFTS.

The arrangement of the gas cylinder, operating cylinders and brake shoes, with relation to the guides, is shown best in the plan view in Fig. 5. The high pressure of the stored gas, multiplied by the cylinder area, gives tremendous pressure on the brake shoes—over 10,000 lbs. The weight of the entire device is 369 lbs.

That this catch strongly appealed to the Commission is shown by the fact that, during nine months, tests were conducted on seven different occasions. Its adaptability to use with steel guides (which none of the other devices possess, excepting the Wilkinson) also strongly recommended it.

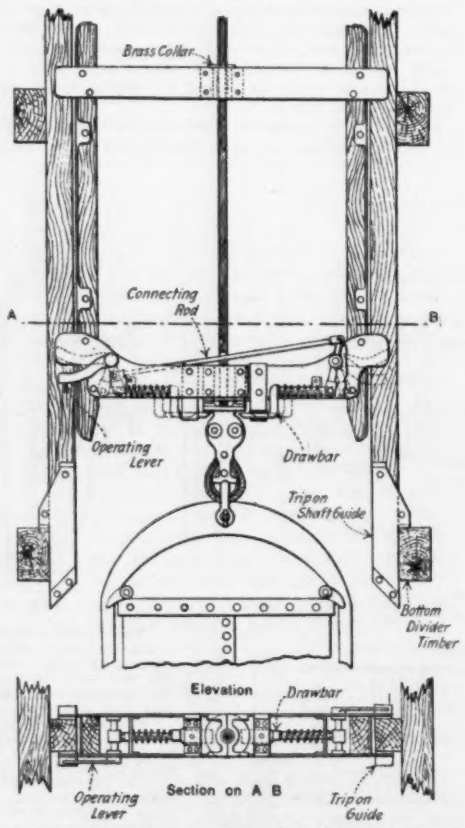


Fig. 7. The Berry Crosshead Guide, for Use in Shaft Sinking with Buckets.

At the first trials the brake shoes were found to have insufficient area to hold, and they were accordingly enlarged. Ultimately, after trials and suitable adjustments of load and of cylinder size, the Schweder catch operated satisfactorily under all imposed conditions, on wood guides (4 × 4-in. pitch pine). The brakes brought the cage to rest with varying lengths of slip, 25 to 30 ft.—with a running downward start before release. Gas pressures of from 800 to 900 lbs. per sq. in. were used. The total weight of the moving system in these trials on wood guides was about 3,100 lbs. With long running starts of several hundred feet, load about 2,500 lbs. total (including weight of cage and mechanism), and 4 × 4-in. pitch-pine guides worn to 3¾ × 3¾ ins., the device worked satisfactorily when the cage was released at a downward speed of 2,200 ft. per min. A previous and similar test, on similarly worn guides, had resulted in failure; whereupon means were added to allow for wear in the guides.

With steel guides the Schweder catch proved eminently successful. The guides were 60-lb. steel rails. With a total suspended weight of 2,880 lbs., a 30-ft. running downward start, and release at a speed of 1,020 ft. per min., with 92 ft. of rope attached to the cage, the latter was stopped after a further drop of about 21 ft. And *with the rails well greased,* under the same conditions, save that the downward speed of the cage was 30 *ft. per min. greater,* the cage was stopped in less than 15 ft. The gas pressure used was 900 lbs. per sq. in.; in the second trial, 15 minutes after the cage had been stopped, it was 780 lbs. per sq. in.

A modification of the Schweder device, suitable for use on passenger skips in inclined shafts, is shown in Fig. 6. From an examination of the end elevation it will be seen that the operating cylinders actuate, for each rail, two levers; these levers grip the rails as would a pair of pliers, holding the car. The Commission made no recommendation of this modification of the Schweder catch (see paragraph 168 of the report).

THE WILKINSON SAFETY CATCH.—Although, as stated in paragraph 165 of the report, this catch proved unsuccessful and was finally abandoned in favor of the Schweder catch—though the Wilkinson catch was designed for use with steel as well as wooden guides—it may be of interest to note that it consists of scissors-like levers mounted beneath the cage, operated both by springs and by the weight of the cage. Steel grips are brought into action, which clutch the sides of the guides.

THE BERRY CROSSHEAD FOR BUCKET SINKING.—As stated in paragraph 178 of the report, this device bears the endorsement of the Commission for use in bucket sinking. No tests were made of this crosshead at the time of the other tests covered in the foregoing abstract.

Referring to Fig. 7, the steel "trips" on the shaft guides are at the bottom set of the shaft. When the bucket is lowered to this point, the levers at each side of the crosshead at the bottom are raised by the trips, and the drawbars locking the bucket and crosshead together are pulled back. (The rope passes through brass collars in

the horizontal members of the crosshead, and runs freely therein).

When the crosshead is released from the bucket, it remains on the guides at the bottom set and the bucket runs on down to the sump, swinging free below the crosshead. On the up trip the rope runs freely in the brass collars until the bucket reaches the crosshead, when the removal of the weight of the crosshead from the levers releases them and locks bucket and crosshead together.

A Combined Electric Lighting and Signaling Device for Vertical Sinking.

In "Annexure No. 4" to the report there is an illustrated description of an improvement in electric lighting and signaling apparatus for vertical shafts during the sinking period.

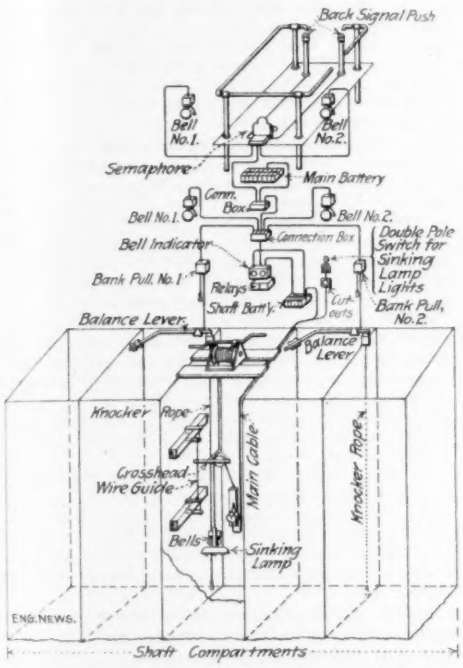


Fig. 8. Diagram of Circuits in the Gould Electric Lighting and Signaling Apparatus for Vertical Shaft Sinking.

In past applications of electric lighting to shaft sinking, usually by winding the conducting cable on a drum, in some cases the drum has been operated on the surface; but at depths greater than 500 ft. the more common method has been to have about 300 ft. of cable on the drum, making it necessary to lower the hoisting winch bodily with every 200-ft. increase in depth. Both these arrangements require the breaking of the circuit every time the lamp is raised or lowered.

The equipment illustrated in the report is the invention of Mr. R. H. Gould, and combines both electric lighting and signaling facilities. In Mr. Gould's description of the apparatus, he says:

The winch remains on the surface, and on it is wound a comparatively thin steel rope of $^3/_{16}$-in. diameter, by which the crosshead (see Fig. 8) is suspended. The sinking lamp, to which are also fixed the bells, is suspended by a 4-core cable protected with a braiding of phosphor-bronze wire; the cable is led over the sheave of the crosshead, and is fastened at its other end by a clamp, suitably fixed to two dividers. The necessary connections are made here for the lights, as well as for the bells; these connections are permanent as long as the clamp remains in this position. When the lamp is to be raised, the crosshead is pulled up by the winch. To prevent the crosshead turning, a guide-wire about 180 ft. in length is provided.

The cable is about 330 ft. long, and as the clamp is fixed at first about 80 ft. above the bottom of the shaft, it follows that the clamp and guide-wire must be shifted down for about every 250 ft. of shaft sunk. The lowering of the whole arrangement can be done in a few hours. The clamp is fixed with two U-shaped bolts to two of the dividers. After shifting the clamp and guide down, the permanent wire connecting the clamp need only be lengthened.

Since the winch remains on the surface, the lamps remain at the bottom of the shaft until after the men have ascended from lighting the blasting fuse, and can be lowered again in advance of the men descending. The lamp is, therefore, always at the bottom when men are below, and it is for this reason, and because no disconnections are made, that it is admirably adapted to carry bells, which not only permits of all signals given in the shaft being heard at the bottom, but provides return signals at the bottom of the shaft.

All signals in the shaft are given with the ordinary knocker line. At the top of each working compartment a balance lever is provided, the knocker line being attached to this lever by a clamp, which permits of the line being lowered conveniently as the shaft is deepened.

The movement of the balance lever is transmitted to an ordinary electric bell-pull which causes a bell to ring at the bank and in the engine-room, at the same time opening a relay and the semaphore, and the relay rings the corresponding bell on the sinking lamp through an independent battery. The importance of this relay will be understood when it is mentioned that whatever may happen to the sinking lamp or bells thereon—the bell wires may be severed, or they may be short circuited—nothing will interfere with the correct delivery of the signals to the surface.

The arrangement is really only a new combination of existing apparatus, with the exception of the semaphore; the latter is fitted with one white and one red disk, and is placed in front of the engine driver, and shows him from which compartment the last signal was given.

Thé Gould apparatus has been in satisfactory operation for over three years at the Geduld shaft, in the Transvaal. Fig 9 is a photograph of the sinking lamp in use there, showing the bells beneath the bonnet.

Extract from the Mining Regulations of the Transvaal.*

SECTION IV.

Articles 19-31....Winding.—General.
Articles 32-39....Winding.—Signals.
Articles 40-42....Winding.—Raising or lowering persons.

GENERAL.

18. Windlasses, whims, whips, and the like in use at or in workings shall be provided with a stopper, pawl, or some other reliable holder, and care must be taken that the hooking on and off of buckets, kibbles, or other receptacles is done without danger to the workmen.

19. Where winding is effected by means of an engine, an adequate brake shall be attached to every drum and kept in proper working order. Such brake must be so arranged that, be the engine at work or at rest, it can be easily and safely manipulated by the engine-driver when standing at the levers controlling the engine. Spare parts—brake-blocks, etc.—shall always be kept in stock at the mine. The Inspector of Mines shall at all times have the power to order or conduct a test of the efficiency of all brakes.

20. The connection between rope and bucket, kibble, or other means of conveyance must be of such a nature that no accidental disconnection can take place.

21. All ropes used for winding purposes shall be of approved quality and manufacture, free from any defect. Wire ropes only shall be used for winding persons, except in prospecting shafts and winzes of a maximum depth of 100 ft. Wire ropes whether used for winding material or persons, shall be made of steel, and the wires used in the construction of the ropes shall be of sizes suitable for use with the sheaves and drums fitted. At the request of the Inspector of Mines, an adequate sample from the end of any winding rope shall be supplied to him.

Fig. 9. Sinking Lamp Used with Gould Apparatus, Showing Bells.

22. When tools, wood, or other materials are to be let down or hoisted up in a shaft, their ends, if projecting above the top of the bucket, kibble, or other vehicle, shall be securely fastened to the winding rope or to the bow of the receptacle.

23. In sinking shafts, the bucket or other means of conveyance shall only be filled up to the level of the brim. Before the bucket or other means of conveyance leaves the top or bottom of the shaft, it shall be steadied under the supervision of the workman in charge.

24. In no case shall any cage, skip, kibble, or other receptacle be directly lowered to the bottom of a shaft when men are working there, but must be stopped at least 15 ft. above the bottom until the signal to lower it further has been given by one of the sinkers thereat. This rule shall not apply to shafts in which the sinkers are not more than 50 ft. from the banksman.

25. Ladder-ways shall be provided in all shafts in the course of sinking to within such a distance of the bottom as will secure them from damage in blasting, and from the end of such ladder-ways chains or chain-ladders shall be extended to the bottom of the shaft.

26. Vertical shafts exceeding 100 ft. in depth shall be provided with guides for kibbles, unless exempted in writing by the Inspector of Mines. Such guides shall always be kept extended down to the lowest set of timbers; also the crosshead shall be allowed to travel to the lowest set but one, and in no case shall the lowest set of timbers be more than 50 ft. from the shaft bottom.

27. Persons engaged in sinking operations in a shaft bottom during the winding of rock, material, or water, or while timbering or other repairs are taking place, shall be protected from the danger of falling material, tools, etc., by a covering extending over the whole area of the shaft, such covering in the case of vertical and steeply inclined shafts to be not more than 50 ft. from the shaft bottom, sufficient space only being left for the passage of the sinking conveyance or conveyances (skip, bucket, or kibble).

No person engaged in sinking operations in a vertical shaft, or a shaft dipping at 60° or over, shall be permitted to work therein, unless he wears a hard hat of a type approved by the Government Mining Engineer. In the case of a colored employee, such hat shall be provided by the manager. Should a working shaft be sunk deeper while ordinary winding is going on, the men employed at the bottom of such shaft shall be securely protected by a cover overhead.

28. In vertical shafts where cages are used, the landing place of each winding compartment shall be provided with a self-closing cover, gate, or gates.

29. At every shaft station where it is necessary for workmen to pass from one side of the shaft to the other, provision shall be made for them to do so without entering or crossing a winding compartment; such passage shall be securely fenced off from moving parts of machinery.

30. Entering or crossing a winding compartment of a shaft is prohibited, except to ascend or descend, and for purposes of repairs. This regulation shall not apply to persons employed in timbering vertical shafts while sinking operations are being carried on.

31. No winding shall be permitted while repairs in the winding compartment are being made, beyond what is necessary for such repairs. This shall not prohibit persons from working below the lowest point from which winding is taking place, provided that such persons are securely protected by a suitable covering. The word "repairs" mentioned in this regulation and in regulation 30 shall be taken to include the oiling of rollers and pulleys.

SIGNALS.

32. Every winding shaft, if exceeding 50 ft. in depth and not exempted in writing by the Inspector of Mines, shall be provided with some efficient means of interchanging distinct and definite signals between the top of the shaft and the lowest level from which winding is carried on, and the various intermediate stations for the time being in use. The workmen at the bottom of a shaft where work is carried on shall be provided with efficient means of interchanging distinct signals with the surface.

33. Where one or more compartments in a shaft are set apart for the hauling of persons, in addition to the system of signals between the top and bottom of the shaft provided for in regulation 32, a separate set of signals must be provided, so that signals may be exchanged between the shaft-top and the engine-driver.

34. The engine-driver is prohibited from starting his engine before he has received a distinct signal.

35. Only persons duly authorized by the manager, mine overseer, or shift bosses are allowed to give a signal for the winding of material. Special instructions shall be issued by the manager forbidding access to the signal wires to any person other than those in charge of them, and special care shall be taken to guard against the signal wires being accidentally put in operation.

36. At every shaft or shaft station where persons are regularly allowed to ride, signals for raising or lowering a person or persons shall be given only by qualified European banksmen and onsetters, who shall be responsible for the observaince of the rules referred to in regulation 42 (e), (f), (g), and (i), and that the correct signals are given and the doors and covers of the cages properly fixed. The manager may give permission to responsible persons to use the mine signals for their own conveyance.

In signaling, the following shaft signals shall be used—knocks or rings:

1—RAISE when engine at rest.
1—STOP when engine in motion.

*We have, with the exception of Americanizing the spelling, printed these regulations verbatim. A number of terms not in common use in this country we have allowed to stand unchanged. Throughout the entire publication of the report we have retained the word "winding" instead of substituting the word "hoisting," more common among American mining men.

2—LOWER.
3—MEN about to ascend or descend.
3—IN REPLY. MEN may enter the cage or other conveyance.

In no case shall any person enter a cage or other conveyance until the back signal "3" has been received.

The engine-driver when receiving the signal "1" or "2," signifying to raise or lower any person, must wait at least ten seconds before starting to wind, except under the circumstances set forth under regulation 39.

37. Special signals, in addition to the above, may be used at any mine, provided they are easily distinguishable by their sound or otherwise from the foregoing code, and do not interfere with it in any way.

38. The before-mentioned code of signals, as well as any special signals that may be in use on a mine, shall be painted on a board or enamelled plate, not less than 20 ins. × 20 ins., in the form of a distinctly legible notice, and shall be posted up in the engine-room, and at the top of the shaft, and at all shaft stations for the time being in use.

39. In shaft sinking, special care must be taken that the engine-driver is notified by a prearranged signal when blasting is about to take place, so that he may be ready instantly to raise persons employed in blasting on receipt of the final signal.

RAISING OR LOWERING PERSONS.

40. No winding plant shall be used for the raising or lowering of persons, unless the special written permission of the Inspector of Mines has been granted. Permission shall not be granted unless the foregoing regulations and the following subsections, namely, (a), (b), (c), (d), (e), (f), (g), (h), (i), (j), and (k) of this regulation (40) have been proved to the satisfaction of the Inspector of Machinery by actual test to have been complied with so far as they are applicable to each individual case.

(a) The winding engine shall be such that:

(1) Running at various speeds with light and heavy loads, it can be readily slowed and stopped, and after stopping can be immediately started again in either direction by the engine-driver.

(2) It can lift from bottom to top of shaft the maximum unbalanced load on one drum. This provision shall not apply in cases where other means exist enabling persons employed below to reach the surface.

(3) Each winding drum uncluthched from the engine can be maintained in a position of rest with no more slipping than 1 ft. by means of its own brake or brakes, (a) while bearing its maximum working load when winding persons, and (b) when this load is increased to the extent of doubling the authorized load of the cage or skip. In estimating this authorized load, 150 lbs. weight shall be allotted for each person.

(4) In the case of a hoist where no part of the rope is rigidly fixed to the drum, there shall be no dangerous slipping of the rope on the drum under any possible working conditions.

(b) There shall be on the drum of the winding engine such flanges or horns, and also, if the drum is conical or spiral, such other appliances as may be sufficient to prevent the rope from slipping.

(c) There shall be not less than 3 rounds of rope upon the drum when the cage or other conveyance is at the lowest point of the shaft from which hoisting is effected. The end of the rope shall, where applicable, be properly fastened round an arm or the shaft of the drum.

(d) Every engine used in raising or lowering persons shall be provided with a reliable depth indicator, in addition to any marks on the rope, which will clearly and accurately show to the engine-driver at his driving seat at all times the position of the cage or other conveyance in the shaft, and which will, moreover, in shafts exceeding 300 ft. in depth, ring a bell in the engine room when the conveyance is 60 ft. from the top landing place.

(e) Where difference of gradient in a shaft necessitates reduction of winding speed, such positions shall be plainly marked on the depth indicator.

(f) A reliable speed indicator or governor must be attached to the winding engine, if considered necessary by the Inspector of Mines.

(g) Some suitable automatic device to prevent overwinding of cages or other conveyances shall, where possible, be provided at every winding shaft or winding engine. If the winding apparatus cannot be provided with some automatic contrivance to prevent over-winding, then the cage or other conveyance, when men are being raised, shall not be wound up at a speed exceeding 250 ft. per min. after the cage or other conveyance has reached a point in the shaft to be fixed by the Inspector of Mines.

(h) The headgear shall be carried without obstruction to the skip-way to such a height as to allow a clearance of at least 25 ft., in which the cage or similar contrivance can travel freely in case of an over-wind. The Government Mining Engineer may grant permission for headgears which were erected previous to these regulations coming into force, and which do not comply with the above conditions, to be used.

(i) Winding ropes shall not be used for raising or lowering persons when, owing to deterioration, the breaking strain has become reduced to below six times the maximum working load. In case a winding rope is used for other purposes besides the transport of persons, the maximum working load permitted, when raising or lowering persons, shall not exceed 0.85 of the maximum load when the rope is in use for other purposes. The maximum working load shall include the weight of rope in the shaft when the conveyance is at the lowest working point, as well as the weight of the skip, cage, or other conveyance and its contained load.

(j) Winding ropes newly put on, as also the connecting attachments between the rope and the cage, skip, or other conveyance, shall be carefully examined and properly tested as to their working strength by some competent and reliable person authorized thereto by the manager, and shall be used for the ordinary transport of persons in shafts only after having been run two complete trips up and down the working portion of the shaft, the cage or skip being loaded to the full authorized extent. The result of the above examination shall be immediately recorded in a book which shall always be accessible to the Inspector. This book, to be termed the rope record book, shall contain the following particulars of winding ropes:

(A) Maker's data of rope when new or a copy thereof certified to by the manager:
Name and address of manufacturer.
Date of manufacture.
Date of purchase.
Length of rope in feet.
Diameter and circumference of rope in inches or (in the case of flat ropes) width and thickness of rope.
Weight per foot in pounds.
Construction of rope:
Number of strands.
Class of core.
Construction of strands:
Number of wires.
Diameter of wires (decimals of an inch.)
Class of core.
Class of steel of which wire is made.
Breaking stress of steel of which wire is made (tons of 2,000 lbs. per sq. in.).
Breaking load of rope (tons of 2,000 lbs.)
(B) History of rope in use:
Name of shaft in which rope is used.
Compartments in which rope is used.
Date on which rope was put on.
Dates of shortening.
Dates of re-capping.
Dates of turning end for end.
Dates of tests after shortening.
Breaking stress of wires at these tests.
Date when rope was taken off.
Each record shall be signed by the person responsible for the required examination.

(k) Cages, skips, or other conveyances used in vertical or steeply inclined shafts, except during sinking operations, shall have a proper roof or cover; and shall have proper safety catches where applicable. Cage entrances shall be fitted with doors so as to prevent any portion of the body of any person riding therein from accidentally coming into contact with the timbering or sides of the shaft, and the doors must be constructed in such manner that they cannot open of themselves.

41. Prospecing shafts not exceeding 100 ft. in depth, where winding is done by manual or animal power, shall be exempted from the provisions of the preceding regulation.

42. Where winding in shafts in accordance with regulation 40 is permitted, the following regulations shall be strictly observed:

(a) One, or more than one, competent person, specially deputed by the manager for the purpose, and whose name or names must be registered by him in a record book—such book to be termed the machinery record book—shall carefully examine:

(1) At least once each day, the winding ropes and their attachments to the cages and drums, the brakes, depth indicators, the cages and their safety catches, the pulley wheels, and all and every external part of the winding arrangements upon the proper working of which life depends.

(2) At least once a week the guides and the winding compartments generally, the signalling arrangements, and the external parts of the winding engine.

(3) At least once a year the winding engine as to the working condition of the internal parts.

(4) At least once a month the structure of the rope, for the purpose of discovering the amount of deterioration of same. For the purpose of this examination, which shall be made by the Resident Mechanical Engineer in charge of the machinery at the mine, the rope must be thoroughly cleaned at selected places, and the Resident Mechanical Engineer shall note any reduction in diameter and proportion of wear in the rope, and shall record same in the machinery record book.

(5) At least once in six months in the case of a round rope, and once in three months in the case of a flat rope, the rope shall be re-capped and a portion of length not less than half the circumference of the pit-head sheave cut off the lower end. The portion of the rope removed shall be tested in the mechanical laboratory of the Mines Department at the expense of the owner (at a cost not to exceed £4) to whom a certificate shall be furnished. At each occasion of re-capping the connection between the rope and the skip, cage, or other conveyance shall be annealed. A true report of the result of every examination above mentioned shall be recorded without delay in the machinery record book, which must be kept at the mine especially for the purpose, and shall be signed by the person who made the inspection. This record book shall at all times be open for the inspection of the Inspector of Mines and the Inspectors of Machinery. Should, as the result of such examination, any weakness or defect be discovered by which life or limb may be endangered, the defect shall immediately be reported to the manager and remedied, and no person shall be lowered or raised until the defect is made good.

(b) So soon as the rope becomes defective it shall no longer be used for the transport of persons unless the damaged part be at the end and be cut off.

(c) Ropes out of which any defective portion has been cut and the ends again spliced, and ropes which have been previously in use in places beyond the manager's control, shall not be used to raise or lower persons.

(d) At every mine where persons are raised or lowered, at least one spare rope of the description to be provided for in regulation 40 (j) shall always be kept in reserve ready for use.

(e) While persons are riding in a shaft, the winding of mineral or material must be discontinued, except where a separate engine is used for raising or lowering persons. No workman shall take with him in the cage or bucket any heavy articles, especially drills or other tools, except for the purpose of shaft repairs. This rule shall not apply to any onsetter or banksman, who shall be especially authorized in writing by the manager to travel with and distribute such articles.

(f) No one is allowed to ascend or descend a shaft on the side or bow of a skip, or on the top of a loaded truck, skip, or bucket. Riding in partially loaded cages, skips or buckets is only permitted to persons in charge of underground works, sinkers, and to workmen employed to do repairs in the shaft. The same applies to unprotected cages, skips or buckets in vertical or steeply inclined shafts.

(g) In no case shall a greater number of persons ride in any cage or other conveyance at any one time than can be conveniently accommodated therein with safety.

The number of persons allowed to ride at one time in a cage or other conveyance shall be fixed by the Inspector of Mines, and shall be kept posted up at each landing place.

(h) No person travelling in a cage or other conveyance shall change his place therein while the conveyance is in motion.

(i) After any stoppage of winding for repairs, or for any other purpose exceeding an hour's duration, each cage or other conveyance, before any person is allowed to ride therein, must be run a complete trip up and down the working portion of the shaft at least once, with a view of ensuring that everything is in good working order.

(k) When winding persons, the engine-driver shall in no case be allowed to run the engine at a greater speed than that fixed upon when the permission to use the engine for the purpose was granted, and he shall take care that shocks in starting and bringing the engine to rest are avoided, and that cages or other conveyances are set down gently at stopping places.

A NOTABLE BOILER RECORD is reported in a pamphlet soon to be issued by the Rust Boiler Co., of Pittsburg, describing tests on one of its boilers made by Prof. William Kent, of Syracuse University. One of these tests was for capacity and one for economy. In the capacity test, a 335-HP. boiler, with 3,350 sq. ft. of heating surface, was operated at 210½% of its rated capacity, or, in other words, developed over 800 HP. A Roney stoker was attached to the boiler and 38 lbs. of coal were burned per sq. ft. of grate per hour. The evaporation from and at 212° per sq. ft. of heating surface per hour was 7.26 lbs. The remarkably high capacity was in part due to the draft furnished by a high chimney, which gave a net draft of 1 to 1.1 ins. in the stack. In the economy test the boiler was operated at 5% above its rating, yet it evaporated 12.216 lbs. of water from and at 212° per lb. of combustible. A summary of the main results is given:

	Capacity.	Economy.
Water evaporated from and at 212° per sq. ft. heating surface per hour, lbs.	7.26	3.63
Boiler horse-power obtained per cent. of rated horse-power	210.5	105.1
Water evaporated from and at 212° per lb. of combustible	10.859	12.216
Water evaporated from and at 212° per lb. of dry coal	9.416	10.505
Efficiency of boiler based on combustible, %	69.17	75.85
Efficiency of boiler and grate, based on dry coal, %	68.88	75.55
Coal burned per sq. ft. of grate per hour	38.00	17.01

THE LOETSCHBERG TUNNEL AND ITS RELATION TO ALPINE RAILWAY ROUTES.

With the construction of the Simplon Railway and its great 12½-mile tunnel it might be supposed that many years would elapse before any new projects would be considered for additional or rival lines across the Alps, but as a matter of fact several such projects are already in the preliminary stages of promotion, with reasonable prospects that some at least will be carried into execution before many years. The commercial aspects of these Alpine railways, and the conditions which warrant their construction, are discussed editorially in this issue, and the locations of the existing and proposed lines are shown upon a map on page 614 of this issue.

A line which is now actually under construction and involves an 8½-mile tunnel is that known as the Loetschberg Railway, the object of which may be briefly explained as follows: At the north end of the new Simplon tunnel the railway turns westward through Switzerland to a connection with the railway system of France. The older St. Gothard tunnel affords connection with the railways of Germany and northern Europe, and in order to give these railways access to the new and more favorable route by the Simplon, the construction of the Loetschberg Railway was decided upon. This, as will be seen by the map, starts from the north end of the Simplon tunnel, and extends to Frutigen, a distance of only 36 miles, where it connects with a line forming communication with various railway routes to the north and west. This railway, therefore, while insignificant as far as length is concerned, will form the closing link in a very important line of communication, with numerous ramifications from either end. From a commercial standpoint, the line will be of the highest importance, and is assured of heavy traffic.

TRANS-ALPINE RAILWAYS AND TUNNELS.

Before dealing in detail with this railway, it may be well to give some description of the map on p. 161. In the first place, it will be understood that only a few of the more important railway routes are shown, sufficient to indicate the relations of the trans-Alpine routes to the movements of commerce. It will be understood, also, that the great ranges of the Alps form the western and northern boundary separating Italy from France, Switzerland and Austria. The two extremes of the several railway lines of communication are open lines, with no mountain tunnels of importance. The first of these is the coast line from Marseilles (France) east to Genoa, and the second is the line from Innsbruck (Austria) south (through the Brenner Pass) to Verona. The three existing Italian tunnel lines are as follows: (1) the Mt. Cenis line, into France; (3) the St. Gothard line, to Switzerland and Germany; (4) the Simplon tunnel to Switzerland and France. The Arlberg tunnel (2), which is also shown, connects Austria with Switzerland and France.

Five projected tunnels are also shown. The first of these, and the one which is now being promoted actively in France, is the Mt. Blanc tunnel, which (with some new railway connections) would give a short and direct route for through traffic between France and Italy. As an auxiliary to this there is the proposed tunnel of the Faucille, which would also form an improved connection of the French railways with the Simplon tunnel. An alternative to the Mt. Blanc route is that of the Little St. Bernard, but Italian interests appear to favor the Great St. Bernard tunnel project, connecting with Switzerland instead of France. The reasons for this are stated elsewhere. The next project is that of the Splugen Pass, with a 15-mile tunnel, connecting Italy with eastern Switzerland. The map also shows a proposed open-air line for a connection between Marseilles and Turin. All these lines are referred to elsewhere.

THE LOETSCHBERG RAILWAY AND TUNNEL.

With the above general explanation of trans-Alpine railway conditions, we turn now to the details of this short but important and difficult mountain railway by the Loetschberg route. A plan and profile of this are shown in Figs. 1 and 2. For these particulars we are indebted to Mr. Charles R. King, C. E., of Bristol, England. A parallel route formerly proposed as an alternative to the Loetschberg, and known as the Wildstrubel route, was to extend from Leuk (near the mouth of the Simplon tunnel) to Lake Thun. The Loetschberg tunnel now under construction is one of the two great mountain borings necessary for the new through route between the north coast of France and Brindisi

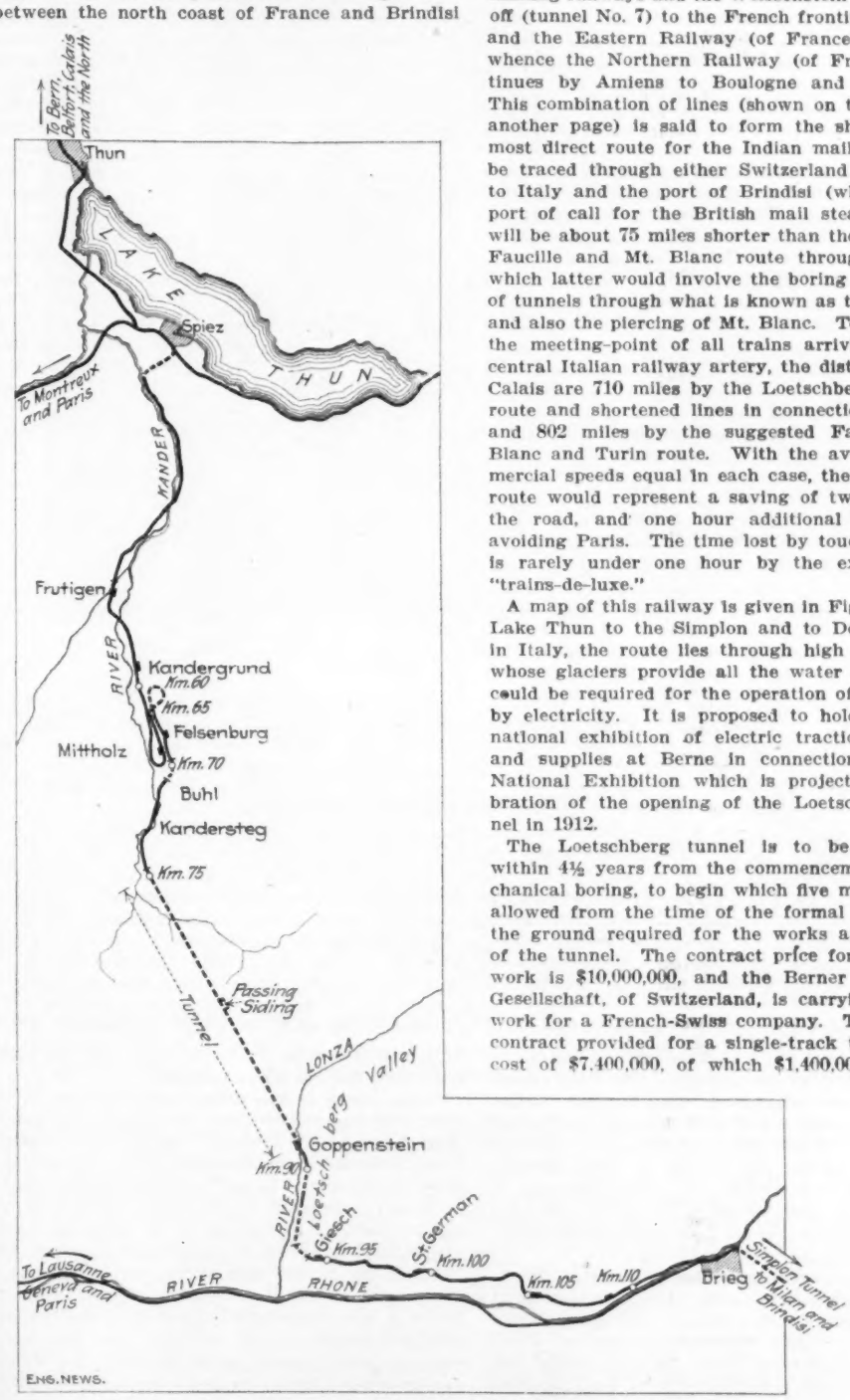


FIG. 1. MAP OF THE LOETSCHBERG RAILWAY; SWITZERLAND.

(on the Adriatic Sea), the latter being the calling place for steamers on the Oriental routes. The other tunnel is the Simplon, which was constructed first, although it was held by some that the former tunnel (through the Bernese Alps) should have been the first undertaking. Work was commenced at the northern and southern ends of the Loetschberg tunnel on Oct. 15 and Oct. 28, 1906; and the contract calls for its completion by September, 1911.

The Loetschberg tunnel will be shorter than the Simplon, the respective lengths being 12.25 and 8.52 miles. It will be the third longest tunnel in Europe, coming next to the St. Gothard tunnel, which is 9.25 miles long. It will, however, be the second longest double-track tunnel in Europe, the St. Gothard being the longest. The lines to be built in connection with this new tunnel will run almost due north from Brieg, at the north end of the Simplon tunnel, to Frutigen, in the Engstligen valley, on the opposite side of the chain (36.27 miles). Thence an existing railway runs to Spiez (on Lake Thun) and to Berne, the Swiss capital. The route is then by existing railways and the Weissenstein tunnel cut-off (tunnel No. 7) to the French frontier at Delle, and the Eastern Railway (of France) to Laon, whence the Northern Railway (of France) continues by Amiens to Boulogne and to Calais. This combination of lines (shown on the map on another page) is said to form the shortest and most direct route for the Indian mails that can be traced through either Switzerland or France to Italy and the port of Brindisi (which is the port of call for the British mail steamers). It will be about 75 miles shorter than the suggested Faucille and Mt. Blanc route through France, which latter would involve the boring of a series of tunnels through what is known as the Faucille and also the piercing of Mt. Blanc. To Piacenza, the meeting-point of all trains arriving on the central Italian railway artery, the distances from Calais are 710 miles by the Loetschberg-Simplon route and shortened lines in connection with it; and 802 miles by the suggested Faucille, Mt. Blanc and Turin route. With the average commercial speeds equal in each case, the new Swiss route would represent a saving of two hours on the road, and one hour additional by simply avoiding Paris. The time lost by touching Paris is rarely under one hour by the extra-special "trains-de-luxe."

A map of this railway is given in Fig. 1. From Lake Thun to the Simplon and to Domodossola, in Italy, the route lies through high mountains, whose glaciers provide all the water power that could be required for the operation of the trains by electricity. It is proposed to hold an international exhibition of electric traction methods and supplies at Berne in connection with the National Exhibition which is projected in celebration of the opening of the Loetschberg tunnel in 1912.

The Loetschberg tunnel is to be completed within 4½ years from the commencement of mechanical boring, to begin which five months were allowed from the time of the formal transfer of the ground required for the works and the line of the tunnel. The contract price for the whole work is $10,000,000, and the Berner Alpenbahn Gesellschaft, of Switzerland, is carrying out the work for a French-Swiss company. The original contract provided for a single-track tunnel at a cost of $7,400,000, of which $1,400,000 were allowed for the plant and electrical installations at both ends. This has now been modified, as noted, to provide for a double-track tunnel. The heavy grades of 2.7% will also be reduced to a length of only 2.5 miles (between Goppenstein and the Rhone valley) by means of a modification of the original plan now being elaborated. No power stations, equipment or transmission lines are included in this price.

A profile of the new line is shown in Fig. 2. The elevations above sea level are 2,234 ft. at Brieg, the Italian end; 4,084 ft. at the summit, in the tunnel; and 2,562 ft. at Frutigen, the Swiss end. Thus the vertical rise is 1,850 ft.

from the Rhone valley at the Italian side, and 1,522 ft. from the Kander valley on the Swiss side. The lowest point is at Brieg Baths (2,207 ft.). The conformation of the Rhone valley, between Brieg and St. German, enables relatively easy grades to attain the lower end of the great valley of the Loetschberg, but thence (between Giesch and Goppenstein) the rise is 2.7% in a straight line, and for the most part tunneled through the lateral spurs on the east side of the valley. The new line will run almost parallel to, and within a mile of, the old line from Brieg to Lausanne for a distance of 11 miles, in order to reach (at Giesch) a height in the valley of 1,437 ft. above the old line following the bed of the Rhone, near Raron.

On the north side there is no corresponding facility for attaining the mouth of the tunnel. From Frutigen southwards the distance from the present railway terminus to the mass of the mountain chain is short, and there is no alternative but to follow up the valley of the Kander. This river, or torrent, has a grade of 3% from Frutigen to Mittholz (5.2 miles). To reach the plateau of Kandersteg it has been necessary to resort to a long double loop and helicodial tunnel (as shown on the map). The reason for this is that at Buhl, the bed of the river in crossing a former landslide 1.67 miles in length, has an

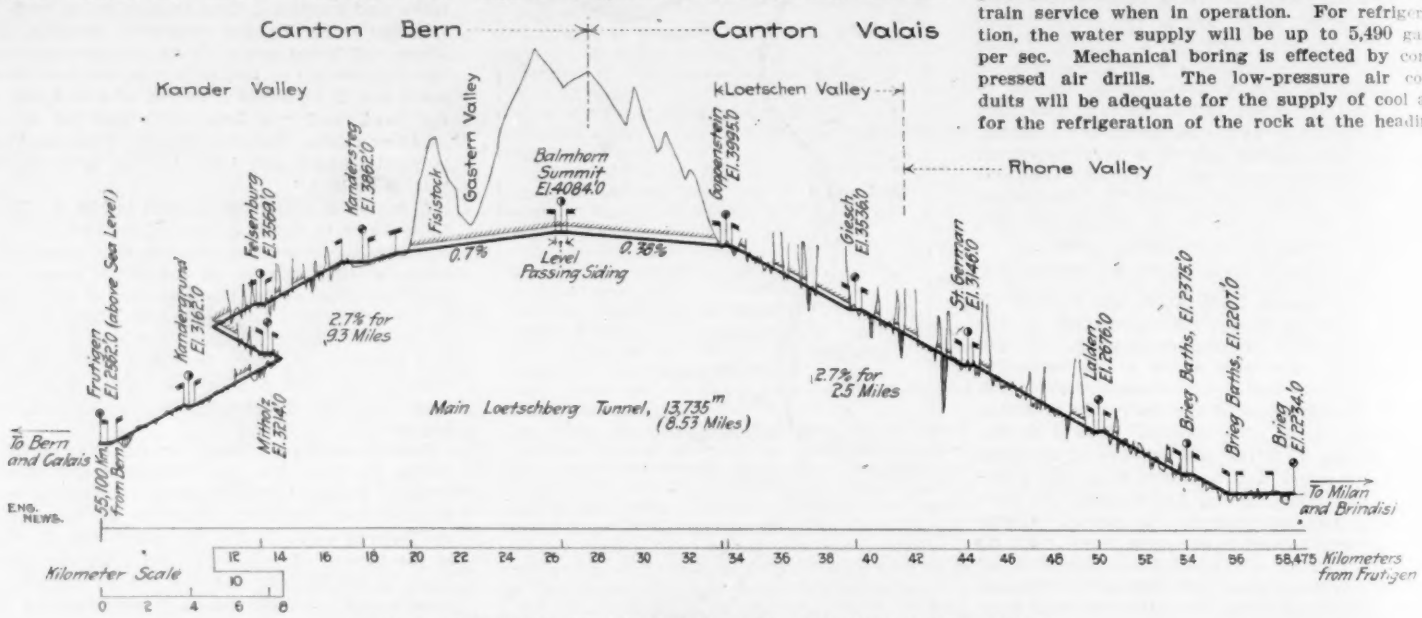


FIG. 2. PROFILE OF THE LOETSCHBERG RAILWAY; SWITZERLAND.

average grade of 5%, which renders the valley impracticable for further advance. The loops shown bring the railway line back to the same point after traversing a distance of 3.72 miles and attaining an elevation of 328 ft. in this distance. This is to be seen on the profile, Fig. 2. The distance from Frutigen to the plateau of Kandersteg is 10 miles, and the difference in altitude is 1,305 ft. The average grade is 2.5%, but the maximum is 2.7% for 9.3 miles.

This long grade exceeds that of all great trunk-line mountain routes in Europe that have been built in recent times. The St. Gothard Railway in Switzerland has maximum grades of 2.6%, except 2.7% for three miles between Bodio and Giornico. Such grades could have been avoided in the Loetschberg by starting the tunnel lower down the Kander valley and increasing the length of the tunnel to 13 miles, but in this case the cost for a single-track tunnel would have been $14,000,000. But the 22.3 miles of approach lines on a 1.5% grade would have cost $4,600,000, as compared with the 28.52 miles of approach line with a 2.7% grade and costing $5,020,000.

The following considerations have had the greatest possible importance in relation to the construction of a modern trunk-line mountain railway. The 13-mile tunnel, with its easy-grade line and equipment complete, would have cost $22,940,000. A similar single-track tunnel of 8.50 miles, with a heavy-grade line and equipment complete, would have cost $16,560,000, or a saving of $6,380,000 in first cost. Experience has shown that while heavy grades may effect a saving in first cost they ultimately cost more than lines with easy grades, the cost of operation overbalancing the first-cost economy. In the case of the Loetschberg it was reasoned that if electric traction was adopted, the steepness of the grade would enable this system of power transmission to prove a real advantage, as such transmission depends for its economy on regular and constant load. This is difficult to arrange with the express-train loads of 500 to 600 tons on level lines, but the grades of 2.7% would compel the division of trains into small train loads at short-time intervals, approaching more or less to local electric railway practice. They would therefore insure an even distribution of the load. Great differences of level have very little influence on cost of traction when electrical traction is employed. The relative economy in traction on grades of 1.5% and 3% was worked out at $761 per mile. Applying this excess to the whole length of the Loetschberg line, and capitalizing it at 4%, the sum only amounts to an extra $660,000. This only reduces the higher cost of the line with 1.5% grades to $4,600,000 above that of the line with 2.7% grades. The figures given are not capable of application, by comparison, with lines of precisely similar character that might be built elsewhere for electrical traction.

Water power is exceedingly plentiful the whole year round in the Bernese Alps, as in the great Alps beyond the Rhone. Coal is very costly, being imported from Westphalia, the nearest coal fields in Germany. In the canton of Berne, which is deeply interested in the financial success of the Loetschberg as well as in the Simplon, there are numerous interests (direct and indirect) in the industry for the manufacture of water-power plants and electrical equipments. The State of Berne is also financially interested in the largest electrical works on its territory, and has sovereign rights over a great number of water powers not yet leased to power users. Even with cost of traction equal by coal and by water power, Switzerland, as a whole, has enormous interests in the exclusive use of energy derived from water and in the transmission of that energy by the intermediary of electrical current whenever possible. Moreover, as it is probable that the whole route from Lake Thun in Switzerland to Lake Maggiore in Italy will be operated before long by electric current, the operation of light train loads at frequent intervals will accord with the working of the trains of the Milan suburban electric line (with steam-driven power plant), known as the Milan-Varese Railway, which connects at Arona with the southern extremity of the newly-built Simplon line. In this way the connection with the present heavy trains of 400 to 500 tons hauled by steam locomotives will be effected at the central station in Milan, where the division can be effected without serious inconvenience to travelers. At present the division of trains into small units further south could not be practised on those steam-operated lines without resort to steam motor cars. The new Loetschberg route, from Thun to Brieg, 51 miles, is estimated to yield $1,[illegible]00 from all traffic receipts at a total cost for working of nearly $400,000, the total net gain yearly being estimated at $640,000.

The location of the line now under construction is similar to the project of Messrs. Hitzman & Greulich (1901), in which the same maximum grade of 2.7% was provided, in place of 3% as suggested by the tunnel syndicate already mentioned. The chief engineer, and consulting engineer for the committee authorizing the enterprise, Mr. Zollinger, strongly favored the heavy grades of 3% or 2.7%, the latter being eventually adopted. The tunnel work is being carried through by the syndicate, which is in no way interested in the length of the line or tunnel, its grades, or the system of traction to be adopted. The maximum temperature to be met in the tunnel is estimated at 40° C. The ventilating plant is to be capable of dealing with this temperature and also to serve for the needs of the train service when in operation. For refrigeration, the water supply will be up to 5,490 gals. per sec. Mechanical boring is effected by compressed air drills. The low-pressure air conduits will be adequate for the supply of cool air for the refrigeration of the rock at the heading face during the period of greatest heat. It is a double-track tunnel. In the duplicate single-track tunnel arrangement of the Simplon, the great advantage of the parallel gallery for ventilation and drainage is fully recognized, but it is said to occasion (particularly in the unlined sections of its length) heavy cost for its maintenance.

The power for the work at the Loetschberg tunnel is derived from power stations built for the operation of the train service. These stations are situated at Kander and Hagneg, on the north side, taking power from the Kander torrent. The station on the south side derives its power from the Longa torrent. This torrent drains all the glacier sources in the great Loetsch valley; and the railway under construction runs alongside the left bank of the valley, between Goppenstein and Giesch. The cost of these stations and power plants is not included in the cost of the new railway route, nor in the first costs of railway traction, because this and the production of hydro-electric power is reserved exclusively for the Cantonal Power Supply Department. The cost for power to be consumed is, however, reckoned in the estimates. For the construction work on the tunnel the power required is estimated as follows: 1907, 400 HP.; 1908, 1,000 HP.; 1909, 1,500 HP.; 1910 and 1911, 2,500 HP. This is an average of 1,590 HP. It corresponds to 10,186,830 KW.-hrs. at the motors, or (assuming an efficiency of 60%) of 15,000,000 KW.-hrs. in

round figures at the generators. In the cost of traction, the expense for electrical power is assumed at 11 cts. per mile. Passenger trains are to range up to 140 tons in weight, and the speed is estimated at 31 mi. per hr. on grades of 1.5% to 2.7%. Freight trains up to 240 tons would be hauled at 20 mi. per hr. on the same grades. The consumption of energy at the power stations is computed at 9,420,000 KW.-hrs., the mean and maximum outputs of the northern stations being 685 and 2,300 KW., and of the southern station 955 to 2,900 KW. The system of electric traction is to be decided upon at a later date, it being anticipated that notable improvements may have been introduced before the completion of the tunnel in 1911. Omitting the power stations and the locomotives, the cost of the line includes an item of $710,000 for electrical installations over the estimated cost had the line been worked with steam locomotives.

At the beginning of June, 1907, the advance heading of the north side (Kandersteg) was bored 1,371 ft., and at the south side (Goppenstein) the heading had progressed 1,213 ft. Operations of clearing the ground before the portals were begun in November, 1906. The progress so far made is therefore less than with the Simplon in the first seven months' work, for which the corresponding figures were 2,063 ft. at the north, and 882 ft. at the south end. At both the Simplon and the Loetschberg tunnels there were existing railways at their north ends, while no such means of communication and for transport of supplies existed at their south ends. A considerable difference exists, however, in the means available for transport for the work of the Loetschberg as compared with the Simplon. The north end of the former is about 8.7 mi. by road from the terminus at Frutigen, while the north portal of the Simplon, in the broad Rhone valley at Brieg, was only one mile beyond the terminus at Brieg. The south portal of the Simplon was 12 mi. from the nearest station, but with a main roadway connecting the two points. The south portal of the Loetschberg at Goppenstein is only five miles from Gompel on the Rhone Valley Railway, but in a wild, uninhabited valley, without road communication. The difficulty of transport on this end of the Loetschberg, and the absence of settlements for the provisioning of the workmen, has increased the cost of the undertaking. It will also account for slower progress at that end.

A REINFORCED-CONCRETE ADDITION TO A BRICK BUILDING.

By L. J. MENSCH,* M. Am. Soc. C. E.

About eight years ago the Rocky Mountain Telephone Co. erected a three-story building, 31 x 93 ft., on State St., Salt Lake City, for their central exchange and offices. It was found, after a few years, that the increasing business required more space, and the building was enlarged by increasing the width to 51 ft. This addition was hardly finished when they found that the additional floor space was insufficient and in a short while they might need four times the space which their enlarged building offered them. The only additional lot they could obtain was in the rear, only 51 x 77 ft. in area. It was obvious that, with so small additional space, several stories would have to be placed on top of the old building to fill all the requirement of floor space, especially the requirement of one large room, technically known as the operating room, in which all local and long-distance lines center. The old building (Fig. 2) was built of 17-in. and 21-in. brick walls with concrete footings 3 ft. 6 ins. wide, and the old-style long-span Golding expanded metal and channel arch floor construction was supported by the brick walls and a line of 6-in. cast-iron columns. The foundation of these walls and columns could only carry a small additional load, and would have been utterly unable to carry the weight of the three additional stories (of which two only were to be built at this time).

*Monadnock Building, San Francisco, Cal.

The accompanying figures show the structural solution of the problem. New reinforced concrete pilasters were built on the north side inside the building (on account of the neighbor objecting to an outside pilaster), and on the south side on the outside of the building. New reinforced concrete foundations were built on both sides of the walls, and the pilasters rested on three 15-in. steel beams, which were supported by both footings and placed in position one at a time, by cutting a hole in the wall only large enough for one beam. When the brick work over one beam was tightened up by iron wedges, the adjacent hole was cut and a new beam inserted and so on. Although the walls were interrupted by many windows, and these not all in a vertical line, this difficult work was done without causing the slightest crack in the building. The Golding arch construction being of such very doubtful value in tying the walls together, it was decided to tie each pair of opposite pilasters together by 1½-in. tie-rods at the first and fourth floors. In order to diminish the free unsupported lengths of the south side pilasters they were tied to the brick walls about every 5 ft. by 1-in. bolts, and at the third floor level tied together by an ornamental tie-beam that portion of the fifth floor which is not supported by the wall pilasters.

The annex, 51 x 77 ft., is a reinforced concrete skeleton building with 12-in. brick curtain walls. The basement walls are of 24-in. plain concrete with reinforced concrete footings about 7 ft. wide. The wall columns are 24 x 20 ins., reinforced by four 1⅛-in. rods from first to fifth floor. The interior columns vary from 20 x 20 ins. in the basement to 12 x 12 ins. in the fourth story and the reinforcement varies from four 2-in. rods to four ¾-in. rods tied together every 12 ins. by ¼-in. ties and connected at each floor by gas pipes 3 ft. long, filled with grout. The columns adjacent to the old building had to have cantilever footings similar to the wall plates in the old building. The columns divide the building in nearly square panels, which are divided up by the girders from 15 to 16 ft. apart in both directions. Half the number of all rods in girders were bent up and extended into the adjacent girders for from 18 to 24 ins. Stirrups were of ¼-in. round steel and from 4 to 12 ins. apart.

The third story ceiling was suspended from the fourth floor and had to be strong enough to carry a weight of 50 lbs per sq. ft. in order to support

FIG. 1. REINFORCED-CONCRETE ADDITION TO A BRICK BUILDING AT SALT LAKE CITY.
(Note exterior pilasters at right.)

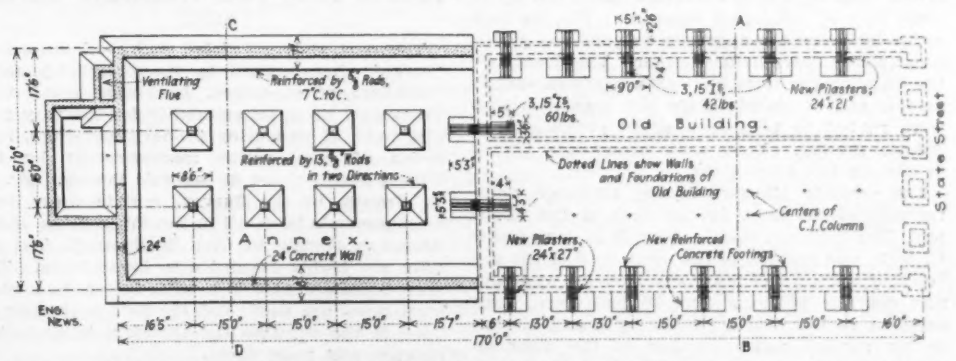

Ventilating Flue
Reinforced by ¾ Rods, 7' C. to C.
Reinforced by 13, ¾" Rods in two Directions
A n n e x.
24" Concrete Wall
Old Building.
Dotted Lines show Walls and Foundations of Old Building
Centers of C.I. Columns
New Pilasters, 24"x27"
New Reinforced Concrete Footings
New Pilasters, 24"x21"
State Street
ENG. NEWS.

FIG. 2. FOUNDATION PLANS OF COMBINATION BRICK AND CONCRETE BUILDING AT SALT LAKE CITY.

lengthwise of the building. These pilasters support the fifth floor, the sixth floor and future roof story and the walls from fifth floor up. It was found that the 12-in. wall load from the fourth to the fifth floor could be carried by the old wall, and the interior cast-iron columns were strengthened by pouring grout into the hollow space and letting ½-in. rods drop into the grout, giving a reinforced-concrete column inside the cast-iron columns, which enables them to carry the many cables placed between the ceiling and fourth floor to reach the automatic connecting machines placed on fourth floor.

The operating room in the fifth story is about 50 x 170 ft. and necessitated spans in the sixth floor 50 ft. long, in annex and over the old portion. As another story is to be added to the building these girders have to carry also the future sixth story and roof. They were figured as an arch without hinges and therefore the steel

rods in the outside pilasters were bent up into the lower part of the beam. The girders are 15 ins. wide and 48 ins. deep and reinforced by from eight to ten 1⅜-ins. rods 56 ft. long, bent into the columns to follow the line of stress. The lintel at the sixth floor was made 4 ft. 5 ins. deep in order to tie the frames well together, as earthquakes are not of so very rare occurrence in Utah. A temporary wooden roof covered by a composition roof was built over the sixth floor, which also contains a blue print house for the company's use built of metal lath and plaster walls and roof.

The floors have a 2½-in. cinder concrete finish in which the gas and electric pipes were imbedded and the linoleum was directly pasted on the smoothed cinder concrete.

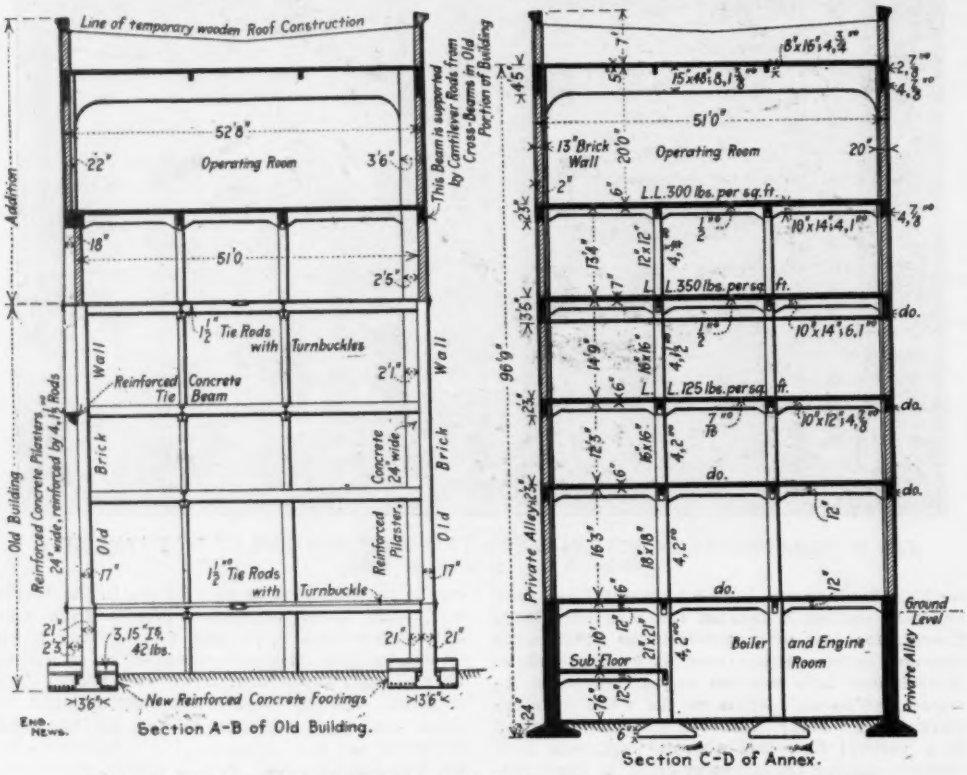


FIG. 3. VERTICAL SECTIONS THROUGH OLD BUILDING AND THROUGH ANNEX.

A ventilating flue at the outside of the building was built 3 ft. 6 ins. by 7 ft. 8 ins., inside dimension, and 125 ft. high, with 6-in. concrete walls reinforced by 7-16-in. rods, 12 in. c. to c. in both directions.

At each floor in the rear of the building the reinforced concrete fire escape platform cantilevers from each floor for 6 ft. 6 ins. The stairs were also of reinforced concrete. The inclined slabs, including the necessary column and girder construction, were built together. The floors and the steps proper were built afterwards in special moulds and of marble chips and cement, which were rubbed to produce a slight polish and to imitate granite. They were afterwards placed in position like stone steps.

The concrete pilasters in the exchange room represented the most difficult task of the whole job. The exchange board, about 70 ft. long and 6 ft. high, was parallel to the north wall of the old building and only 27 ins. away from it, while the new concrete pilasters were 25 ins. deep. Any accident to the board, caused by heavy shocks or by surplus water coming on the floor or through cracks, would have disabled thousands of wires and caused tremendous losses. As it was impossible to brace the column forms to the exchange board, expansion bolts were fastened to the walls on both sides of the form, from 18 to 24 ins. apart in vertical direction and the forms wired to the bolts by means of No. 8 wire. The cracks were closed by battens and oakum, and the concrete was mixed rather stiff, and only two feet of the column was concreted at a time. As the concreting of the north side pilasters could not be carried on by bringing the concrete into the various offices or exchange rooms, thereby spoiling floor and furniture, it had to be poured from the fifth floor through 8-in. collapsible sheet iron tubes, often for a height of 50 ft. This, of course, caused a tremendous noise in the exchange room, which could be heard through the phones all over the city, and for this reason was carried on about midnight.

Much of the outside work was laid in freezing weather and in times of snow-fall. The snow was shoveled out of the girder forms, boiling water poured into the forms to heat the wood and especially the steel rods. The concrete was mixed with boiling water, which took the frost out of the sand and the crushed gravel; a number of salamanders were kept going day and night, and the forms were sprinkled from the underside to prevent baking of the concrete in the state of setting. The tops of the floors were protected by boards and burlaps.

This work was designed and constructed by the writer of this article.

TESTS OF INVAR TAPES IN BASE-LINE MEASUREMENT.

The new alloy of nickel and steel known as "invar," characterized by its remarkably small coefficient of expansion, has been tested very thoroughly as to its suitability for the very precise work of measuring primary base-lines, in a series of comparative measurements by the United States Coast & Geodetic Survey. Mr. O. B. French, of the Survey, reports upon these measurements in detail in the Proceedings of the American Society of Civil Engineers.* The results are highly favorable to invar tapes. The accuracy obtainable is a trifle better than when steel tapes are used, and the field-work may be done in the daytime and therefore is somewhat cheaper and more rapid.

Invar, which contains about 36% of nickel, was discovered by C. E. Guillaume of Paris a few years ago. It has found extensive application in the construction of physical instruments, where its low coefficient of expansion was of value. The discoverer has made thorough tests of the properties of the alloy, including practical base-line measurements, making a measurement through the Simplon tunnel after the completion of the tunnel last year. This measurement was made with invar *wires*. The United States authorities prefer tapes to wires and made no use of the new metal until it was obtainable in tape form, which was only in December, 1905. Tapes with a measuring length of 50 m. (164 ft.) were then procured from England, and preparations made for measuring six primary bases whose lengths had not yet been determined.

These tapes, ¼-in. wide by 0.02-in. thick, weighing about 0.027 oz. per ft. (as against 0.022 oz. per ft. for the Survey's steel tapes), were tested for mechanical properties, with these results: Tensile strength about 100,000 lbs. per sq. in.; yield-point. about 70,000 lbs. per sq. in.; no change in length under a stress of 8000 lbs. per sq. in. kept on for 60 hrs., nor under stresses of 12,000 lbs. per sq. in. repeated many times. Steel tapes have about twice this strength. The coefficients of expansion of five invar tapes averaged 0.00000041 per degree Centigrade, or 0.00000023 per degree Fahrenheit, while four steel tapes averaged 0.0000114 per degree Centigrade or 0.0000063 per degree Fahrenheit; the former value is about one twenty-eighth the latter. The invar tapes were, however, softer, more easily bent, and less elastic than the steel, and required about the same care to keep them free from rust, though theoretically invar oxidizes less rapidly than steel.

The six base-lines measured, and their finally-determined lengths, reduced to sea-level, are: Point Isabel, Texas, 24,222.5442 ft.; Williamette, Oregon, 45,983.5601 ft.; Tacoma, Washington, 39,542.2699 ft.; Stephen, Minn., 30,247.6132 ft.; Brown Valley, Minn., 26,973.2080 ft.; Royalton, Minn., 31,611.1666 ft. They control parts of the 98th Meridian triangulation and of the Pacific Coast triangulation between the 39th parallel work and the Puget Sound work. All six were measured with three steel tapes and with three invar tapes; each tape being used on about two-thirds the length of a base, two complete steel measures and two complete invar measures were obtained. The steel tapes were standardized in the field, before and after the entire series, and the invar tapes were standardized before and after at the Bureau of Standards in Washington, D. C.

The methods of measurement were those regularly used in tape base-line measurements of the Survey; 4×4-in. posts were set for the ends of the tape, and 2×4-in. posts as intermediate supports at the middle of each tape-length. These posts were set by a separate party in advance of the measuring party; the posts were set carefully to line and level (or to grade, where required). Copper marking strips were nailed on the station posts by the measuring party to carry the tape-end marks. All the measurements with the steel tapes were made at night, and all those with invar tapes in the daytime. The speed of measurement was about 7 to 8 mi. per day. Temperatures were read by two thermometers attached to the tape 3 ft. inward from each end. For the steel tapes they were read to 0.1° C., for the invar tapes only to whole degrees. The tension was uniformly 33 lbs., applied by a spring-balance tape-stretcher at the forward end.

The results of the comparative measurements are exhibited by the probable errors, as shown in the following tabulation:

Base	Probable Error, mm. Steel Tapes	Invar Tapes	Combined	
Point Isabel...	± 5.68	± 3.19	± 3.02	= 1: 2,450,000
Willamette ...	± 8.09	± 4.20	± 4.09	= 1: 3,430,000
Tacoma	± 7.39	± 4.05	± 3.99	= 1: 3,020,000
Stephen	± 8.20	± 4.51	± 4.25	= 1: 2,170,000
Brown Valley..	± 5.79	± 2.64	± 2.83	= 1: 2,910,000
Royalton	± 4.27	± 3.91	± 3.24	= 1: 2,980,000
Mean...	1: 1,500,000	1: 2,630,000		1: 2,760,000

Thus the probable error of the measurements made with the invar tapes is smaller in every case than the probable error of the steel tape measurements, and averages only about half as great. Mr. French concludes that invar tapes form the most economical and most accurate apparatus available for measuring primary base-lines. The expensive and awkward iced-bar apparatus is the only device exceeding them in accuracy.

*"Invar (nickel-steel) Tapes on the Measurement of Six Primary Base Lines," by Owen B. French, M. Am. Soc. C. E., American Society of Civil Engineers, Proceedings, October, 1907, pp. 889-912.

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We conclude in this issue our reprint of the Transvaal Commission's report on the use of winding ropes, safety catches and appliances in mine shafts and would call special attention to the Mining Regulations of the Transvaal Government covering these matters, which are printed as part of this report.

As most of our readers are aware, the labor supply of the Transvaal mines consists of Kaffirs or other natives of South Africa, supplemented during the past few years with some importations from Asia. Yet the safety of these men of the "subject races" is guarded by the government with a fidelity and a watchfulness which may be profitably studied even in our own land of democratic ideals. It is a remarkable illustration of the zeal for protecting human life which is a notable feature of British laws and British administration.

In this country all these matters respecting the safeguarding of workmen is in the control of the individual state governments. While a few states, like Pennsylvania, where mining is a prominent industry, have done something toward Government regulation, there is, we believe, in the majority of the states where mining is carried on, no legislation whatever for the protection of miners. The individual mine owner is left free to expend much or little on appliances and methods for protecting his workmen from accident. Although there are notable examples where a broad, far-seeing humanitarian management has provided the best appliances for safeguarding lives and limbs, the very fact that the whole matter is left to the mine owner lowers the standards of American practice and increases to a fearful degree the annual total of human lives and limbs paid for the mineral treasure extracted from Mother Earth.

If anyone doubts this, let him reflect that the stockholders who own the mines judge the efficiency of mine managers by the dividend paid and their ability to keep down expenses. The intelligent mine superintendent who desires to spend money to safeguard his workmen knows that his expense sheets may be compared with those of a neighbor who is willing to run risks in order to save money.

If anyone doubts that our American mine practice is deficient in the matter of safeguarding workmen, let him study the Transvaal Government regulations printed in this issue and see how many American mines he can find whose practice in the matter of safety appliances is as good as these regulations demand.

A few months ago the country was shocked at the story told in the Idaho courts of systematic murder and callous disregard for human life. It is pertinent to inquire the reasons for the growth in whole communities of a contempt for law and indifference to the taking of human life. Making all allowances for the other causes that have made the Western mining communities what they are, is it not reasonable to believe that the prevalence of accidents in the mining industry has contributed, in some degree at least, to the tendency to hold human lives at a low rate. Men who are accustomed to the daily risk of their own lives because of an employer's neglect to provide safety appliances, are not being schooled to hold the lives of others at a high rate.

It is the fashion just now, in certain circles, to decry all Government interference with industry in the way of regulation or control; but in the light of the above facts, it must be admitted that proper regulations are in the long run in the interest of the mine owner as well as the workman. If such Government regulation is proper to safeguard the lives of Kaffirs and Chinamen in South Africa, ought not at least as much care to be taken in a land of democracy to protect the lives of citizen workingmen?

Ought the Federal Government to undertake the draining of the swamp lands of the country in the same manner that it is reclaiming arid lands in the Far West? Certain gentlemen who met in Baltimore last week answered this question with an emphatic, "yes;" and they are pretty certain to have bills introduced at the present session of Congress embodying their views in legislation. We see little prospect, however, that such legislation will be enacted and we are far from clear that its enactment would be for the public benefit.

The parallel with the irrigation work of the Reclamation Service, which is made much of by the advocates of Federal drainage schemes, is not really a parallel at all. The work of reclamation by irrigation is being carried on upon lands owned almost entirely by the Government itself. The swamp lands to be reclaimed by drainage are almost entirely owned by private individuals or by the States. There are many cases of clouded titles which the Federal Government would be powerless to remedy, all such matters being under the sole control of the several States. It may be argued that the Federal Government as now conducted would carry on the work more efficiently and honestly than the separate States; but this is no valid reason why the nation should take over the work. As well might it be argued that the Federal Government ought to construct public buildings for the States because the Pennsylvania and New York state capitols have proved monuments to graft.

If State Governments are corrupt or inefficient, it lies with their citizens to make them better; and in the last analysis, there is no reason to expect on the average better and more honest legislation and administration in the Nation than in the States. In fact, the mere volume of legislation now pressing on Congress for attention is so vast that nothing unnecessary should be added to it. Minnesota and New Jersey and California can make any necessary laws for the reclamation of their swamp lands just as well as Congress. In fact, the State legislatures have far more time to investigate so as to legislate with an intelligent appreciation of local conditions. If there are large profits to be made by reclaiming swamp lands, the State treasuries need these profits much more than the National Government. As for the argument that swamp reclamation is necessary to protect the public health, the mosquitoes which are bred on the swamps and which spread malaria never fly far from their breeding place. If the people of any State are too supine to create a State government competent to protect the public health, they probably deserve to be bitten by mosquitoes until they are aroused to action.

We publish in this issue a very interesting article by Mr. William D. Barber, M. Am. Soc. C. E., on "The Construction and Repair Division of the City of Chicago." The paper narrates the experience of the past eight years in putting on a practical and economical basis what may be called the work of maintenance of the municipality's plant. The task on which Mr. Barber has been at work is one which is found difficult in every city; and we need not confine it to cities, for many private corporations lose large sums of money every year through inefficient conduct of their maintenance department. Because the items of expenditure for repairs are small individually, the fact is often overlooked that their sum total cuts a large figure in the annual expense account. The reasons why these expenses for maintenance and repairs are heavy in the case of a city are not at all difficult to find. If the city attempts to do the work itself, with its own employees, there is apt to be lack of system in the purchase, storage and use of materials, the workmen employed are very likely left with little control, or the control may be that of a local ward boss rather than a responsible city official. Finally the records of such work are apt to be incomplete, so that there is no means of determining whether the work is done economically or extravagantly.

If the other alternative is adopted and it is attempted to have repair work done by contractors, the individual jobs are found to be too small to induce much if any competition, and prices bid will be high. Extras will be worked in and charged at exorbitant prices. The contractor will be largely left to his own devices and may use cheap workmen and poor materials and there is no one to be held accountable if the work fails and goes to pieces in a short time.

On the whole it is probable that there is a higher percentage of graft, inefficiency and wastefulness in the work of maintenance than in the work of new construction; and this applies to other large corporations as well as to cities. It may not even be too much to say that it is in this department that grafters are bred who may afterward undertake to mulct the city or the corporation on a larger scale. For these reasons we believe the system which has been worked out by Mr. Barber for conducting this work on an economical business basis will be followed with interest by engineers.

THE COMMERCIAL ASPECTS OF PRESENT AND PROPOSED ALPINE RAILWAY TUNNELS.

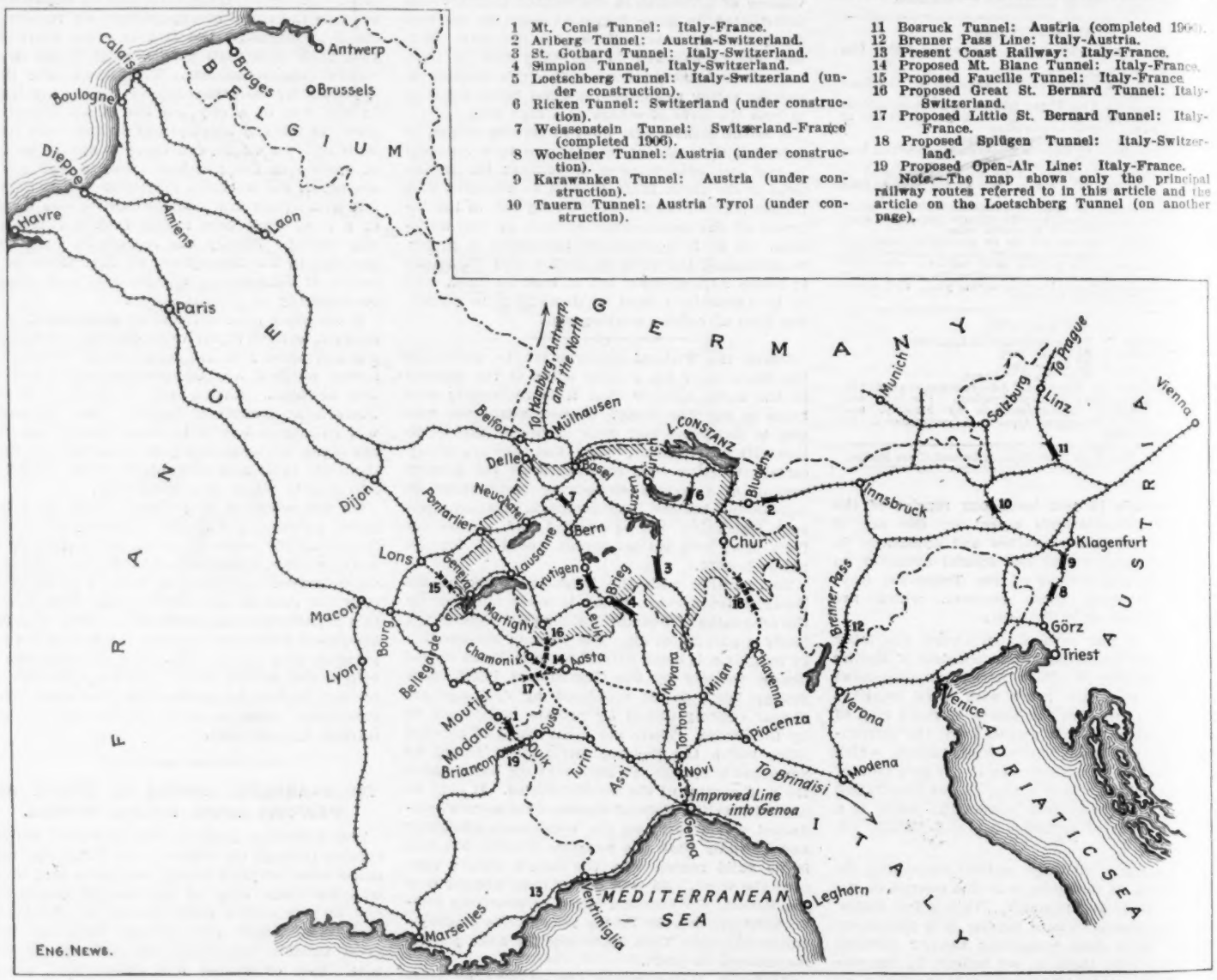
The numerous projects for additional railway tunnels through the Alpine range in Europe must cause some surprise among engineers and others who see them only as engineering enterprises, and do not realize their relation to commercial conditions. There are already three of these great tunnels, connecting the railways of Italy with those of France and Switzerland, besides two routes with open summits. It might appear that these would amply fulfill all traffic requirements, but projects for other tunnels are in various stages of activity. In another column we publish an article on an Alpine tunnel now under construction on a line which will give a new route to the Simplon tunnel, and many of our readers will, perhaps, wonder at the necessity for this little 36-mile mountain railway, involving costly works and an 8½-mile tunnel. It is safe to say that few American readers could, without difficulty, locate the relation of the Loetschberg Railway (between Brieg and Frutigen) to the railway geography of Europe.

In view of these conditions it will be appropriate to present some information as to the several completed and proposed tunnels, and the commercial conditions which have led to their construction or projection. The accompanying map shows their approximate positions, and their relations to the main railway routes. Before going further we may briefly explain the map.

No. 1 is the Mt. Cenis tunnel, connecting Italy with France. No. 2 is the Arlberg tunnel, through which the direct traffic from France and Switzerland to Central Austria is carried. Nos. 3 and 4 are the St. Gothard and Simplon tunnels, connecting Italy with Switzerland, and No. 5 is the Loetschberg tunnel, now being built to give a connection with the Simplon from the north, as the present line turns west at the end of the tunnel. The 2.3-mile Weissenstein tunnel, No. 7, recently completed, improves the northerly portion of the Simplon-Loetschberg route, by straightening the line between Bern and Delle. No. 6 is a new tunnel of considerable length but only local importance, the Ricken tunnel, 5.35 miles long, which creates new lines of communication between northern and southern Europe. The Karawanken railway, extending from Trieste north to Klagenfurt, crosses the mountains by means of the 3.95-mile Wocheiner tunnel (No. 8) and the 4.97-mile Karawanken tunnel (No. 9). The Tauern railway, giving direct connection from here to Innsbruck and Salzburg, pierces the Hohen Tauern ridge with a tunnel 5.30 miles long (No. 10). Farther north, the line to Linz and Prague is reached by the new Pyhrn Pass connection, which contains the Bosruck tunnel (No. 11), 2.97 miles long, under the Pyhrn Pass. The last-named tunnel is single track, but the other three are double-track tunnels, though located in single-track lines. These lines supplement the Austria-Italy connection via the Brenner Pass (No. 12), an open-air summit line, but they connect with tide-water in Austrian instead of Italian territory.

The active projects for new connections across the western Alps are indicated on the map by Nos. 14 to 17. No. 14 is the proposed Mt. Blanc tunnel into France. No. 15 is the proposed Faucille tunnel on a cut-off forming a connection with either the Simplon tunnel (in competition with the Simplon-Loetschberg route) or the Mt. Blanc tunnel, No. 14. No. 16 is the proposed tunnel at the Great St. Bernard, which is a rival of the Mt. Blanc project, being designed to connect Italy with Switzerland and the north, instead of with France. No. 17 is a tunnel proposed under the Little St. Bernard, claimed to be more favorable than the Mt. Blanc route. An open-air connection between Italy and France is also proposed (No. 19), but this as well as the existing coast railway (No. 13) which flanks the western end of the Alps has only local importance, and is not directly related to the question of improved international communication on the main routes of travel.

In the first place it should be explained that there is a great "trade route" running southeast across Europe from the west coast to the Mediterranean, and this is obstructed by the mountain ranges of the Alps, extending northward between France and Italy, and eastward between Switzerland and Italy; further eastward, where it separates Italy from Austria, the barrier is less serious. The most formidable part of the range lies across the "trade route" above mentioned. The development of the existing and proposed routes across the Alps has been undertaken to provide improved facilities for existing traffic,



1 Mt. Cenis Tunnel: Italy-France.
2 Arlberg Tunnel: Austria-Switzerland.
3 St. Gothard Tunnel: Italy-Switzerland.
4 Simplon Tunnel, Italy-Switzerland.
5 Loetschberg Tunnel: Italy-Switzerland (under construction).
6 Ricken Tunnel: Switzerland (under construction).
7 Weissenstein Tunnel: Switzerland-France (completed 1906).
8 Wocheiner Tunnel: Austria (under construction).
9 Karawanken Tunnel: Austria (under construction).
10 Tauern Tunnel: Austria Tyrol (under construction).
11 Bosruck Tunnel: Austria (completed 1906).
12 Brenner Pass Line: Italy-Austria.
13 Present Coast Railway: Italy-France.
14 Proposed Mt. Blanc Tunnel: Italy-France.
15 Proposed Faucille Tunnel: Italy-France.
16 Proposed Great St. Bernard Tunnel: Italy-Switzerland.
17 Proposed Little St. Bernard Tunnel: Italy-France.
18 Proposed Splügen Tunnel: Italy-Switzerland.
19 Proposed Open-Air Line: Italy-France.

Note.—The map shows only the principal railway routes referred to in this article and the article on the Loetschberg Tunnel (on another page).

MAP OF THE PRESENT AND PROPOSED ALPINE RAILWAY TUNNELS IN CONNECTION WITH INTERNATIONAL TRAFFIC ROUTES.

The tunnels marked 8 to 11 represent recent Austrian development in the eastern part of the Alps, where very active work has been going on in the last two or three years in building lines through the summit-ranges. To furnish better communication between Upper Austria and the city of Trieste, the chief Austrian seaport, three new connecting lines, involving four large tunnels, were projected, and are now practically completed. They also improve the international

rather than to develop new traffic. It has been governed largely by national commercial rivalry, and to an important extent also by municipal rivalry (especially as regards the Italian connections), and by railway rivalry in France. It has also been governed by two traffic conditions: (1) The freight traffic between northern European ports and industrial centers and the Mediterranean ports. (2) The passenger traffic, including the great tourist traffic to Italy and also that of what is known as the "overland route" to India and the East. For many years the steamships on the oriental routes have made Brindisi (in Italy), near the southern end of the Adriatic Sea, a port of call for passengers and mails. Here the outbound steamers from England, after passing around France and Spain and down the Mediterranean, receive passengers and mail leaving London some days later than the steamers. In the same way, the homeward bound steamers land passengers and mails for

British and continental cities, which are thus saved considerable time as compared with the longer and slower route by sea. Thus, very costly works may be warranted by a resultant saving of a few hours in time of transit.

The trade and travel between Italy and its ports and Switzerland and northern Europe was, up to 1870, carried by the three great mountain highways crossing the Alps at the Simplon Pass (built by Napoleon in 1806), the Splugen Pass (1822), and the St. Gothard Pass (1824). In 1867, the Brenner Ry. (with an open summit in the Brenner Pass, in Austria) was opened, connecting the Austrian railways with those of Italy. At about the same time the Mt. Cenis railway was opened, crossing the Alps by a switchback line having steep grades, operated by the Fell grip-rail system. The traffic capacity of this was limited, but four years later, in 1871, the Mt. Cenis tunnel was opened, giving a direct line westward into France. It became evident that these new trade routes would absorb so large a proportion of the business that in order to regain a due share of this business and to protect Italian and Swiss interests it would be necessary to build a railway to connect Italy with the countries lying north of the Alps. The three highway routes were all examined with a view to the possibility of railways on approximately the same lines. The Simplon was rejected as being tributary to the interests of France rather than of Switzerland and Germany. The Splugen was rejected on military grounds, as being too near the Austrian frontier, and liable to seizure in case of war. The St. Gothard route was adopted, and in 1869 a treaty providing for the construction of the railway was made between Italy and Switzerland. In 1871, Germany also became a party to the treaty. The great summit tunnel was commenced in 1872 and completed in 1881. While this tunnel is the special engineering feature, it should be understood that the St. Gothard Ry. involved the construction of some 53 tunnels, aggregating about 25 miles in length.

The Arlberg tunnel, on a railway connecting Austria-Hungary with Switzerland and western Europe, was completed in 1883. This line was 80 miles long, from Innsbruck to Bludentz, and had maximum grades of 2.5%. South from Innsbruck runs the line to the Brenner Pass, already mentioned.

The important result of the St. Gothard line in affecting French commercial interests and in taking traffic away from the French railways was early foreseen, and various projects were suggested and preliminary steps taken with a view to the establishment of a rival route. In 1870, the French Government proposed a Simplon tunnel between Italy and Switzerland, as Germany had combined with those two countries in promoting the St. Gothard tunnel. The Franco-German war put a stop to all negotiations of this kind, however, but the matter was revived again in 1875 and in 1880. It was delayed largely by a controversy as to the relative merits of the Simplon and Mt. Blanc routes. In 1886, the Simplon project was revived by Switzerland, and a commission of engineers was appointed to investigate it. After protracted study of several routes, plans were submitted in 1890, and the contract for the Simplon tunnel was awarded in 1893. The treaty, or convention, between France and Italy relating to the construction and operation of the tunnel was signed in 1895.

At that time the two French routes for the "overland mail" were by way of (1) Modane, the Mt. Cenis tunnel and Turin, and (2) by Belfort, Basle, the St. Gothard tunnel and Milan. The time from Paris to Milan was about 19½ hrs. by the former and 22 hrs. by the latter. The limited mail for the steamers, once a week, made the trip from London to Brindisi in about 42 hrs. by the Mt. Cenis route and some hours longer by the St. Gothard route. The regular trains took from 12 to 14 hrs. more. The former route was, therefore, the better, as far as southern Italy was concerned, but from Milan (as a commercial center) the time to London was about 27¼ hrs. by the Mt. Cenis, and 26 hrs. by the St. Gothard. The object of any new route was to get an easier and better line, suitable for higher speed, and enabling a material reduction in time to be made. It should be noted that a low-level line existed by way of Marseilles and along the coast to Genoa, thus flanking the mountain range. The distance was too great, however, for this to enter into consideration as a competitive route for international traffic.

The object of the Simplon tunnel was to give a shorter route, with a lower summit elevation and easier grades, the two latter features involving greater length of tunnel. These objects have been attained, and the route has comparatively little trouble with snow, while it is also free from the long and difficult approach lines of the St. Gothard. The distance from Paris to Milan is 607 miles by this route, as compared with 662 by the St. Gothard, and 666 by the Mt. Cenis. It was estimated that the tunnel could be built in 5¾ years at a cost of $15,000,000, but owing to the great difficulties encountered the time was 6¾ years, and the cost $16,000,000. Excavation by hand was commenced in August, 1898, and by machine drills in November of that year. The headings met on Feb. 24, 1905. The first train passed through the tunnel on Jan. 25, 1906, and the line was opened to public traffic on May 30, 1906; operation by electric traction was established in August of the same year. Further improvements as to time and connections will be effected by new lines and cut-offs in both Italy and Switzerland.

The completion of the Simplon tunnel, the third and largest of the Alpine tunnels on the Italian routes, by no means put an end to the projects for other lines and tunnels, some to form new independent routes and others as auxiliary to the existing routes. The project now receiving the greatest attention is that for the Mt. Blanc tunnel, the purpose of which is to give the French railway system a direct route into Italy equally favorable with that of Germany and northern Europe. At present the only direct connections are by the Mt. Cenis tunnel, and the coast line from Marseilles to Genoa, already noted. The Mt. Blanc route has been covered by many projects since 1836, and the line now proposed is from Chamounix to Courmayeur, as proposed by Mr. Bonelli, the engineer, in 1878. The tunnel with a summit elevation of 3,280 ft. would be 11.47 miles long and cost about $14,600,000, while the approach grades would be only 1.30%. A 10-mile tunnel could be obtained at an elevation of 3,584 ft. and would cost only $12,800,000, but would require grades of 1.5%. The distance between the railway connections at Chamounix (Switzerland) and Aosta (Italy) would be about 36 miles. The Mt. Blanc route would, it is claimed, make the distance from Calais to Brindisi, 1,294 miles, while in conjunction with the Faucille cut-off the distance would be 50 miles shorter than by any of the other routes. The distance from Paris to Genoa would be 540 miles by the Mt. Blanc route, as compared with 592 miles by the Mt. Cenis, 597 miles by the Simplon and 650 miles by the St. Gothard.

On the other hand, it is said that the northern route by the Loetschberg and the Simplon tunnels would be still shorter, but this does not appeal to French interests or promoters. The Mt. Blanc route would, it is claimed, have the disadvantages of high elevation and heavy grades, or the alternative of immensely expensive development lines to keep the grades within 1.25%. It is also said that new railways in connection with the mountain line proper would be required to make it a really competitive route. This, however, is a matter rather apart from the question of the mountain crossing. Even in the case of the Simplon tunnel extensive railway improvements are being made and new lines built to open up new routes northward and to give the best possible connections with Italian industrial and commercial centers. The Mt. Blanc route would inevitably take a large proportion of the traffic which already goes by way of the French railways and the Simplon, with the result that the French lines connecting with the Mt. Blanc route would benefit at the expense of other French lines connecting with the Simplon route.

An alternative to the Mt. Blanc route is that from Bourg by Moutier, and by way of a tunnel under the Little St. Bernard to the Italian lines ending at Aosta. This would give a route more direct than that by Mt. Blanc and Geneva. A rival to these two French routes is that of the Great St. Bernard, running almost directly north from Turin to Martigny, the latter being on the line between Geneva and the Simplon tunnel. This is favored by the Italians as affording a connection with the Swiss rather than with the French railways. As Switzerland has a free-trade policy, this route would avoid the international customs troubles due to the fact that both Italy and France have protective policies. The line would be about 97.3 miles in length and is not intended to touch the present railway system terminating at Aosta (which by the map seems the natural route). The reason for this is largely the commercial rivalry between the cities of Milan and Turin. There is, however, a rival project for a line from Milan to Aosta, the Great St. Bernard and Martigny. According to a description of the projected Turin line, in our issue of July 14, 1904, there would be severe grades for about 60 miles, two tunnels of 7.6 miles and 3.8 miles in length, and ten shorter tunnels. The grade conditions are such as to make the line out of the question for heavy traffic. Electric traction, with current generated by local water-power development, was a part of the project. The elevations would be 774 ft. at Turin, 5,904 ft. and 5,281 ft. at the two summit tunnels, 2,870 ft. in the valley between these summits, and 1,538 ft. at Martigny.

The old project for a railway line and tunnel by the Splugen Pass has already been noted. This was revived in 1890, and again revived in 1906 as a rival to the new route by the Simplon and Loetschberg tunnels. The line would run north from Chiavenna to Chur, a distance of about 50 miles, with maximum grades of 2.6%. The tunnel would be of the tremendous length of 16¼ miles, and on a tangent with the exception of a short portion at the north end. From the Italian portal there would be an ascending grade of 1.85% for about half the distance, followed by a descending grade of 0.3% to the Swiss portal. The summit elevation would be 3,412 ft. It would be a single track tunnel, but with three passing places, each 1,640 ft. long; a peculiar feature of the work is that each passing place would have short stubs which would form headings for a second parallel tunnel in the future. The project provides for electric traction, which is one reason for adopting a grade of 1.85%, as it is considered that steam locomotives with heavy trains could not operate such grades without fouling the atmosphere of the tunnel to a serious or even dangerous extent. Beneath the tunnel proper would be a conduit for drainage and to contain pipes, cables, etc., used during construction and in the operation of traffic. The cost of a single track line on this route is estimated at $25,000,000, of which $16,300,000 would be for the great tunnel.

Two auxiliary routes, involving heavy tunneling, are those of the Loetschberg (in Switzerland) and the Faucille (in France). The first of these, which is described fully elsewhere, and which is now actually under construction, is a line extending northward from the Simplon tunnel (where the present railway turns west) to connect with an existing railway by way of Lake Thun to Berne, and thence west and north by various existing routes through the northern part of France or by way of Basle to any of the great northwestern ports of Europe. On this line is the Loetschberg tunnel. The construction of this line will mean the abandonment of the project for a line on a parallel route by Lenk to Lake Thun.

The second auxiliary is a short connecting line by what is known as the Faucille route, running northwest from Geneva, and shortening the distance between that city and Dijon by 73 miles as compared with the present circuitous route by Bellegarde. It would, however, be a

most expensive line. While only 47 miles in length, it would require about eleven tunnels aggregating 25 miles. Its three longest tunnels would be 9.5 miles, 7.4 miles and 4.2 miles in length, and these would have to be driven through such unfavorable material as loose rock and gravel. The maximum grades would be only 1%, and the summit elevation 1,835 ft. This has been proposed by the French Government as an improved connection with the Simplon tunnel, reducing the time from Paris to Milan by from 3½ to 5 hrs., and reducing the present distance of 1,580 miles from London to Brindisi to 1,400 miles. The Faucille project, however, is generally regarded as a preliminary to a Mt. Blanc tunnel project. As far as the Simplon connection is concerned, two cut-offs have been proposed to improve existing routes. One is by way of Pontarlier and Neuchatel (involving very heavy grades and liable to serious interference from snow), and the other by Pontarlier and Lausanne. The Frasne and Vallorbe cut-off on the latter route is estimated to cost $4,200,000, as compared with $28,000,000 for the Faucille, but French sentiment strongly favors the latter.

The development of Genoa as a port has made great progress in recent years, and, in addition to harbor works and terminal facilities, projects have been considered for improving the means of access by railways. A spur of the Apennines shuts off this city from the interior, involving heavy work for railways aiming at this point, and in our issue of March 24, 1904, we described projects for improved routes from Tortona and Novi into Geneva. These, however, are of a local character. The city of Turin favors the Great St. Bernard route for the new tunnel to the westward, as already noted, as the Mt. Blanc route would connect with an existing line leading directly toward Milan. We cannot attempt to describe or discuss the numerous railway projects having for their purpose the obtaining of shorter, more direct and more favorable through routes in connection with one or other of the mountain tunnels. Detailed accounts of those on the northern side of the mountain will be found in "The Engineer" (London), March 9 and 23, 1906, while the new Italian lines were described in our issue of Aug. 13, 1903.

The Mt. Cenis, St. Gothard and Arlberg tunnels are all double track; but several of the smaller tunnels on the St. Gothard Ry. were built for single track (with roof arch resting on the bench at one side) and afterwards widened. The double-tracking was completed throughout in 1893. The Simplon tunnel is single track, but with a parallel gallery, 56 ft. distant, and the treaty provides that the Swiss Government will enlarge this to a second tunnel when the gross traffic receipts exceed $16,090 per mile per annum. It is now proposed, however, to undertake the work of enlargement at once. The proposal is under discussion at present, and final action on it may be expected within the next year. Some particulars of these great tunnels are given in the accompanying table.

A specially interesting feature of the Simplon is its operation by electric locomotives, thus greatly simplifying the problem of ventilation, to meet which a very extensive plant had been provided. This problem of ventilation has been a troublesome one in all these great tunnels. In these mountain districts there are numerous sites for water-power plants of high capacity, and these are being developed for commercial purposes on both the Swiss and Italian sides. In fact, the development of this "white coal" has an important bearing on many industries in Italy, where coal is highly expensive.

Two water-power plants of 2,000 HP. each operated the compressors and other construction machinery for the Simplon tunnel, and similar plants will undoubtedly be used for work on future tunnels. The application of the water-power to traction is a further and important development, and it is most probable that any future railway project of this kind will include electric traction from its inception. This is indeed the case in the Loetschberg tunnel, as described elsewhere.

It has been suggested that the enormous cost of these great mountain tunnels might have been avoided, or postponed, by the construction of steep-grade switchback lines through the passes, as has been done in several cases in this country. There were two great objections to such a method, however: (1) the deep snows and heavy storms of the upper Alps; (2) (but most important) the necessity for speed and traffic capacity on railways competing for the business which already existed on a great "trade route" and which would increase with better facilities for transportation. As a matter of fact, however, the first railway to cross the Alps was an open line, following closely the route of the highway or post road over the Mt. Cenis. This was operated by the Fell grip-rail system, in which pairs of horizontal driving wheels on the engines were powerfully gripped against a double-headed rail laid on its side on supports between the running rails. This line was opened some years before the completion of the tunnel, but was abandoned.

With all subsequent projects, however, the problem has been much more difficult than that of simply getting a line across the mountains, which has been the problem in the construction of railways across the Rocky Mountains. The Alpine tunnels are incidental parts of great traffic routes, and with each new project it has been necessary to locate a line which would be superior to preceding lines in regard to distance, time and operating conditions. Thus, with tunnel routes existing by the Mt. Cenis and St. Gothard routes, it would have been waste of time to even consider a steep-grade switchback line for the rival Simplon route. The actual length of tunnel was a secondary consideration. What was needed was a line that would attract traffic by its more favorable conditions. It may be noted, for example, that the through traffic of the Simplon tunnel was estimated at 140,000 tons per year, of which 70% would be taken from the St. Gothard and 30% from the Mt. Cenis routes. The same principles and conditions govern the selection of the later routes now being proposed. It may be noted, however, that an open-air line operated on the Fell system has recently been proposed, on a route from Oulx, on the Italian side of the Mt. Cenis Ry., to Briancon, in France. This, however, is not on the main traffic route to the northwest, but is for an improved connection between the south of France and the great industrial centers of Turin and northern Italy. It would shorten the distance between Turin and Marseilles by 62 miles as compared with the present route by Genoa and Ventimiglia. The line would be 24 miles long, and is estimated to cost $3,000,000.

Summarizing the above review of Alpine railway tunnels and tunnel projects, it may be said that while some years of discussion and preliminaries must necessarily pass before any new Alpine line is definitely adopted and commenced, the indications are that the next international Alpine railway enterprise to be carried into effect will be that for a direct route between Italy and France (crossing only a small corner of Switzerland), as an offset to the Simplon route. It is significant to note again in this connection that the former routes have been built successively in rivalry of their predecessors and for competitive purposes. When the Mt. Cenis tunnel had connected France and Italy, the St. Gothard was planned to give Switzerland and Germany similar (but even more favorable) communication. This in turn was followed by the Simplon tunnel in the interests of France. Hardly had this been completed when work was started on the Loetschberg tunnel to give Germany a connection with the Simplon. And at the present time the greatest activity centers about a more direct French-Italian route (probably by way of Mt. Blanc or the Little St. Bernard) in order to restore to France the possession of a route superior to all its predecessors.

In conclusion, reference may be made to the fact that no such great tunnels have been required in this country in crossing the Rocky Mountain range. Indeed the longest railway tunnel is in Massachusetts, the Hoosac tunnel on the Fitchburg Division of the Boston & Maine Ry. being 25,000 ft. in length. The three longest tunnels on transcontinental routes crossing the Rocky Moutains are as follows: Cascade Tunnel, Great Northern Ry. (1890-92), 13,973 ft.; Stampede or Cascade Tunnel, Northern Pacific Ry. (1886-88), 9,850 ft.; Busk Tunnel Colorado Midland Ry. (1890-93), 9,395 ft. All of these are single track tunnels. In building mountain sections of main lines in this country, however, speed and low cost of construction have been governing conditions, and our engineers have displayed marked ability in finding practicable locations through open passes for temporary or permanent lines. Indeed, the Great Northern Ry. tunnel and the Busk tunnel were both built to supersede earlier open lines having summit elevations several hundred feet above the tunnels, while a switchback line was operated across the Stampede Pass during the construction of the tunnel. A mountain tunnel six miles long is, however, projected for the Denver, Northwestern & Pacific Ry., now under construction between Denver and Salt Lake City, and work is to be commenced very soon. This tunnel (known as the Continental Tunnel) was recently noted in our columns; it will pass under James Peak (about 50 miles west of Denver) with grades of 0.70 and 0.25%, while the present route through the Corona Pass has 28 miles of 4% grade. It is expected that the tunnel will be completed in three or four years, giving a low-grade route between the cities named with a saving of 150 to 250 miles in distance as compared with existing routes. With this one exception there is little probability of any mountain tunnels being built in this country that will at all compare with the great Alpine tunnels in point of length.

PARTICULARS OF THE FOUR PRINCIPAL ALPINE RAILWAY TUNNELS.

Tunnel.	Mt. Cenis.	St. Gothard.	Simplon.	Arlberg.
Length, miles	8	9.75	12.40	6.25
Summit elevation	4,388 ft.	3,788 ft.	2,314 ft.	4,300 ft.
Max. thickness above tunnel	5,430 ft.	5,598 ft.	7,000 ft.	2,362 ft.
Max. grade in tunnel	0.3%	0.58%	0.2 and 0.7%	1.50%
Max grades on approaches	2.50%	2.70%	1.65 and 2.2%	2.50%
Progress, per day, max.	9.50 ft.	22.60 ft.	27 ft.	27.8 ft.
Drills used	Hand till 1861 Then air	*Air	Hydraulic	*Air at E. end *Hydr. at W. end
Length driven by hand	3,377 ft.	1,010 ft.	None	1,860 ft.
Progress per day, by hand	1.08 ft.	2.22 ft.	.....	1.67 ft.
Progress per day, by drills	5 to 9 ft.	10 to 22 ft.	18 to 27 ft.	15 to 27 ft.
Cost per ft.	$380	$246	$180	$208
Cost, total	$14,500,000	$11,700,000	$16,100,000	$8,000,000
Single or double track	Double	Double	2 Single	Double
Height of tunnel (above rail)	20.60 ft.	19.68 ft.	18 ft.	25 ft.
Width of tunnel	26.24 ft.	26.24 ft.	14.75 to 16.3 ft.	26.30 ft.
Commenced: S. or E. end	Aug., 1857	Sept., 1872	Feb., 1899	June, 1880
Commenced: N. or W. end	Nov., 1857	Oct., 1872	Aug., 1898	June, 1880
Completed	Sept., 1871	Dec., 1881	April, 1905	May, 1884
Distances (miles):				
Calais to Milan	778	720	707	....
Calais to Genoa	788	814	801	....
Calais to Brindisi	1,398	1,338	1,318	....
Paris to Milan	588	561	518	....
Paris to Genoa	598	654	611	....

*Ferroux compressed air drills were used in the Arlberg and St. Gothard tunnels; Brandt hydraulic drills in the Arlberg and Simplon tunnels.

THE CONNECTICUT RIVER BRIDGE AT HARTford, Conn., one of the largest and most imposing series of granite masonry arches in this country, was formally opened for traffic on Nov. 29. This structure, 1,192 ft. long and consisting of nine arch spans, was built at a cost of about $1,700,000 to replace an old wooden bridge destroyed by fire in 1895. Especial care has been taken in the arrangement of the approaches, particularly on the Hartford side, where the city has constructed a new park system costing about $800,000 for land condemnation and reclamation.

LETTERS TO THE EDITOR.

Credit for Suggesting the Use of the Eastern Section of the Jerome Park Reservoir as a Site for the Proposed Croton Filters, New York City.

Sir: In your issue of Nov. 21, in discussing the report on The Filtration of the Croton Water Supply, made by I. M. de Varona, Chief Engineer of the Department of Water Supply, you state on referring to the selection of the area intended for the Eastern Reservoir at Jerome Park as the best filter site, that work on the construction of that basin "was suspended two years ago on account of recommendations then made by the Aqueduct Commission that the area be used for a filter plant instead of for storage."

This statement is in error and through an oversight unintentionally does not give credit where it is due. The Aqueduct Commission never made the recommendation to install filter plants at Jerome Park. Work was suspended on the Eastern Reservoir because the then Chief Engineer of the Aqueduct Commission, as well as the members of the Burr-Hering-Freeman Commission, held that the Croton supply would soon be filtered, in which case it was necessary to provide a covered reservoir to store the filtered water, and that such a reservoir could and should be built at Jerome Park by changing the original plans for an open reservoir. This will be made evident by quoting from the published report of the Burr-Hering-Freeman Commission of Jan. 16, 1905, pages 31 and 34, as follows:

> A reservoir for filtered water should be covered and protected against dust and the sun's light. Therefore a covered reservoir should be ready on completion of filtration works, and this can be most conveniently and economically provided by a change in the design of the Eastern Basin. . . . . We approve of the temporary cessation of work on the eastern portion of the Jerome Park Reservoir until the question of filtering the Croton water is settled, because this reservoir will then be used to contain the purified water and require a different design than the one now called for.

From the published official report on the filtration of the Croton supply, discussed in your article, it is also evident (see pp. 3, 43 and 51), that the recommendation of the site of the proposed Eastern Reservoir at Jerome Park as the best site for a filter plant to be built on what would otherwise be the roof of a covered reservoir, was first made by Mr. de Varona in his official report to Commissioner Ellison, dated March 28, 1906, and led to the appropriation of $50,000, made by the Board of Estimate to investigate the best site for the filter plants and to prepare plans and specifications for the work.

Yours very truly,

"Engineer."

New York City, Nov. 26, 1907.

The Strict View of Consulting Engineering.

Sir: In several of the more or less ethical monographs which have of late graced the columns of Engineering News, there has appeared a commendable tendency towards the better things in the engineering profession, which must have the support of all those desirous of seeing that profession maintain its rightful place in this workaday world.

The definition of a civil engineer as one who "directs the forces of nature for the benefit and advancement of the human race," is an inspiring one, but it loses its savor should any spirit of charlatanism taint the professional ideals, and it is to the maintenance of these ideals that the energies of the members of the profession should be directed. With the greater part of our New World in its present formative era, it is essential that for the most perfectly judicious and honest realization of its natural resources there be developed a class of men, covering the entire scene of operations, whose education and training shall have been of the highest and whose standard of professional ethics shall be blameless. To such a class of men as these we shall be able to entrust the title of consulting engineer, perfectly assured that it shall be kept free from any stain of partisanship or baseness of policy. The fact that there are at present in the engineering world many men who are striving to enter this class is reassuring, but it is, alas! equally true that there is a vast proportion of our best equipped engineers who do not resist the temptation to enter into commercial life, and even thereafter attempt to palliate the offence by advertising themselves as consulting engineers, "on the side."

It is, I am convinced, to the detriment of the profession, and to the worst interests of its clientele, that the title of consulting engineer is not restricted to its more proper sphere, i. e., to those who act in a purely engineering capacity in advising as to and directing the progress of constructional enterprises. It is not my intention to decry the business of contracting in the least, for that is cooperative with and correlative to the profession, but merely to point out that it should be no more possible to combine it with an engineering practice than it is for a regular medical practitioner to engage in the sale of proprietary remedies, no matter how harmless or beneficial they may be to human health. In isolated cases it may succeed, but the general case goes to show that the development of natural resources should no more be undertaken without the close assistance and advice of a skilled consultant than a great corporation should be launched without the retention of the services of some eminent legal light; and that the consultant should bring to his task a mind as free and unprejudiced in one case as in the other. At a time such as this, when a large disaster has placed the profession on the defensive, so to speak, it is borne home to us that an increase in both the power and responsibilities of the consulting engineer is necessary before the public can be assured that the service is at its highest efficiency, and his salary not merely a sop to appearances. It is only too true that, in the present day, we are often at a loss to know whether the sign of consulting engineer shelters a bona fide practitioner or an estimable gentleman of Hibernian extraction who will dig your ditches or examine your plumbing for a consideration, or even a shrewd-faced agent who will talk you into buying his type of reinforcing steel or insurance policy, also for a consideration. To such papers as Engineering News we look for assistance in freeing the engineering profession from all such ambiguity, and in clearly defining the boundaries of its field.

Yours, etc.,

H. F. M.

New York City, Nov. 25th, 1907.

The Municipal Ownership of Public Utilities; Comparing City Pumping Stations Cost with Private Power Stations Unfair.

Sir: My attention has just been called to Mr. John W. Hill's article in your issue of Oct. 10, 1907, on "The Municipal Ownership of Public Utilities," and, while perhaps it is rather late, I wish to call attention to one feature in the table of costs which is misleading.

Mr. Hill compares the cost of producing a horse-power in a number of city *pumping stations* with the cost of producing the same power in a number of privately-owned *power stations*. While it is doubtless true that municipally-owned plants, as a rule, are more liberally supplied with men and operated with less regard to cost than privately-owned plants, yet any comparison should be between similar plants for similar purposes. That is to say, municipal water-works should be compared with private water-works, and municipal electric works with private electric works. In comparing municipal pumping works with private power-houses, the cost of fuel, as shown in Mr. Hill's table, is in favor of the pumping works, as would naturally be expected, but the cost of labor in the pumping works runs from two to four times as much for the power plants, and this difference in labor cost is inevitable, for the reason that pumping engines are, as a rule, slow-moving machines, the piston speeds in ordinary service seldom exceeding 200 ft. per min., which results in the engines being of very large size and developing very small horse-power, there being comparatively few pumping engines in the country of over 1,000 HP., while the great majority of them, even in the larger cities, do not run much over 500 HP.

On the other hand, power plants, whether privately or municipally-owned, are equipped with engines running at least four times the piston speed of pumping engines, and also carrying higher mean effective pressures through their cylinders. In other words, an engine of a given size in a power-house develops five times the power of an engine of similar size in a water-works pumping plant, and it follows that the attendance required is somewhat proportional to the number of units required to produce a given horse-power.

The same relative difference also appears in the first cost of the machinery, power engines (including generators) costing from $25 to $30 per HP., while pumping engines range from $125 to $150 per HP.

On a strictly "horse-power" basis, the pumping plant would be entitled to four or five times the amount of labor per horse-power accorded the electric power plant, but as a matter of practice, the pumping plant, being operated at slower speeds than the power plant, the proportion of help per unit can be less. Therefore, instead of requiring five times the amount of labor needed for the power plant, the pumping plant can be operated properly at a labor cost of from three to four times the cost per horse-power prevailing in power plants, and such a difference in labor cost is legitimate and unavoidable.

The comparison of repairs on a "horse-power" basis is also misleading, but it is very difficult to compare machinery under such dissimilar conditions on any practical basis, for while the pumping engine, due to its slow speed and low power, is naturally entitled to higher repair account per *horse-power* than the power engine, yet the power machine operating at much higher speed is entitled to a higher allowance for repairs *per engine*, but the fact that its economic life is shorter than the pumping engine introduces still another element of uncertainty, so that there really is no proper basis for comparison on this point.

That municipal administration in all departments is in general much less efficient than private administration is conceded by all, but I believe it will be apparent to Mr. Hill that no comparison between power plants and pumping plants, whether privately or municipally-owned, can be fair if made on a "horse-power" basis.

Irving H. Reynolds.

Youngstown, Ohio, Nov. 25, 1907.

A Lime-Lava Mortar Tunnel Lining.

Sir: It may be of interest to your readers to know that in the lining of the tunnel constructed for the drainage of the valley of Mexico, the brick arch and also the backing was laid entirely with mortar composed of one part of hydraulic lime and one part of sand and one part of what is called in Mexico "Tezontle," which is really lava cinders.

We ground the "Tezontle" in mortar pans, and then mixed the three ingredients together in the same pans. The whole of the tunnel work was very wet, and while we got a very slow-setting mortar we got a mortar that was absolutely satisfactory and perfectly adapted to the conditions under which we used it. This powdered lava has been used in Mexico for years in dam and hydraulic work.

Yours truly,

The Abbot-Gamble Company,

Fred. W. Abbot, President.

32 Broadway, New York City, Nov. 22, 1907.

Tests on Lime and Natural Cement Mortar.

Sir: Referring to the inquiry of Mr. Shaw in your issue of Oct. 24, in regard to the relative merits of lime and cement in localities where the cost of the latter is excessive, I have at hand the results of a series of tests of combination mortars composed of both lime and cement. The tests were for tensile strength and covered both Portland and natural cement mixed with lime paste. We used for Portland cement a 1: 3 mixture, and for natural cement 1: 2. The percentages of lime paste were of the total matrix, and ranged from 4 to 50, the amount of sand being kept constant. We found it necessary to keep the briquettes 48 hrs. in moist air before storing them in water, because those high in lime crumbled when put in water after the customary 24 hrs. in air.

The most interesting and important result of the tests is that the natural cement mortar showed a decided increase in strength when mixed with lime paste. This was true of all the percentages of lime below 20%, and the gain in strength averaged about 25%. The chemistry of cements verifies and explains this action, as it is known that the hydraulicity of natural cements is low, and that the addition of a caustic material, such as lime hydrate, is required to excite the hydraulicity. The same is true in a greater degree of slag which has been quenched from the liquid state by cold water.

The Portland cement mortar decreased in strength roughly in proportion to the percentage of lime in the mixture. Percentages of lime below 20% did not seriously weaken the mortar, but above 20% they did. The latter is true of the natural cement also. No specific tests of effect on activity were made, but it was noted that the time of setting in all tests increased as the percentage of lime increased. However, even the 50% lime tests set hard enough in 48 hrs. to be put in water without any disintegration. It was also noted that the addition of lime greatly increased the adhesion of the mortar, and in spite of well-oiled molds, the briquettes containing lime adhered to them strongly, the adhesion increasing with the percentage of lime.

We found no indications of swelling or disintegration in any of the briquettes containing lime. Lime does not set in water. Our briquettes were all hard enough in 48 hrs. to be put in water. These facts show that the lime hydrate enters chemically into the reaction of the setting of the cement, and does not remain free lime.

Your correspondent might find the use of both lime and cement would afford a cheap mortar for the situation he describes. Natural cement is low in cost, and would probably be cheapened and at the same time strengthened by the use of lime. The tests show that the core of the dam could be laid with such mortar, using either natural or Portland cement, without making any provision whatever to aid the setting of the mortar.

Yours truly,

H. B. Nichols.

Wheeling, W. Va., Nov. 21, 1907.

Notes and Queries.

A printer's error in the reproduction of the Philadelphia regulations for reinforced concrete, in our issue of Nov. 14, pp. 514-515, made the allowable unit stress on concrete in direct compression in columns read 50 lbs. per sq. in. for stone or gravel concrete. This should of course read 500 lbs. per sq. in.

In our issue of Nov. 21, 1907, p. 565, we gave a short description of some iron chimneys that had been coated

with layers of concrete to save them from impending failure. These chimneys were noted as being 14 ft. in diameter, instead of 4 ft., which is their actual size. In this same connection we have the following from F. L. Smidth & Co., Engineers, 41 Cortlandt St., New York:

Some further information about these stacks may be of interest to you, although not at this time news. In some way the rivets in the stack sheets had been sheared. Probably the high-kiln heat versus the below-zero weather of Canada caused the shearing. In any event, many rivets were sheared, and it would have been dangerous for a man to mount the stacks to make any repairs. To overcome this danger and at the same time restore the stacks, we suggested a method of concreting substantially as stated in the paragraph.

A correspondent refers to a statement in our issue of Oct. 10 (foot of last column, p. 377) relating to the use of the device for disjointing cast-iron pipes said to have been used by the Standard Oil Co., of Cleveland, Ohio. He states that inquiry of the company named elicited the response that it knew nothing of the device. We reprint the paragraph in question, in the hopes that some of our readers will be able to give more exact information regarding either the appliance mentioned or some other one equally good:

Mr. W. A. Veach stated that about a year and a half ago he asked Mr. L. E. Chapin, of Canton, Ohio, whether there was not some better method of unjointing pipe than by burning it out in the ditch; and was told that the Standard Oil people, in Cleveland, Ohio, had an arrangement in the way of a jack that one of their men had designed that could be dropped down over the pipe, and had pawls in it that would prevent it from slipping, and that they could push out 6 or 8-in. pipe out of the bell in a few moments; a very practical and very successful device. They relaid more or less cast-iron pipe every year, and they were very much pleased with it and used it entirely.

FIRST ANNUAL CONGRESS OF THE NATIONAL DRAINAGE ASSOCIATION.

The National Drainage Association was organized in Oklahoma City in December, 1906, to promote interest in and further legislation for the reclamation of swamp lands. The charter members of the organization were for the most part men who, in a small way, had attempted to drain swamps in their own localities and who had come to realize that their independent efforts could do little to solve the big problems which close study of the subject brought forth.

It was soon recognized that the engineering difficulties of land drainage on a large scale were less important than the legal difficulties at the outset of the work. The immensity of the marsh area in this country and its wide distribution required some unit supervisory head possessed of large power and wealth before any systematic action in draining such land could be undertaken. Naturally such a head seemed to be the federal government, not only on account of its resources but also because of its analogous supervision of the work of reclaiming the arid lands of the West under the so-called Newlands act of 1902.

For the purpose of interesting members of Congress directly by personal appeal and indirectly through the country at large the members of this association have through the past year been bending all their efforts towards a publicity campaign.

The culmination of this campaign came in the first annual congress of the association, which was held in Baltimore last week, Nov. 25 to 27. As has been noted, little attention was paid to the engineering features of reclamation, but the many sided advantages to be gained by swamp drainage and particularly by federally controlled administration were exploited by speech, illustrated lecture and official address.

These aforementioned advantages are two: the protection of the public health and the increase in value of the land. Under this first head Mr. J. S. Cosgrove, of the State Drainage Commission of South Carolina, read the principal paper, in which he said that malaria does more injury to the working capacity of the people living in the marshy lands of this country than any other disease. Thousands of persons otherwise able bodied are incapacitated or have their productive ability reduced by this disease, which has been conclusively proved to be caused by mosquitos breeding in the stagnant waters of swamps.

In this same connection Prof. E. A. Ayers, M. D., of New York, delivered an illustrated lecture upon the mosquito, its life history and its part in carrying and transmitting disease to human beings. The most interesting portion of this address was the display on the screen of a magnified image of a glass box containing water in which the mosquito larvae were developing. These minute embryos were shown some two or three feet in length. A film of petroleum on the water surface illustrated conclusively the efficiency of this method of killing the insect. After several attempts to reach the air through this oil coating the embryo mosquito would drop to the bottom of the box, dead from lack of air.

Prof. John B. Smith, Entomologist of the New Jersey Agricultural Experiment Station, described in some detail the methods practiced during the past summer in fighting the mosquito on the New Jersey salt marshes. While primarily intended as a public health movement the reclamation of these marshes was so complete that large crops of bulbous vegetables have been raised on the salt waters. Even on the previously cultivated hay fields the improvement in quality has raised the price $2 a ton.

Mr. J. S. Mundy, of Newark, N. J., told how he had drained some 600 acres of swamp land bought at $5 an acre and originally intended for a game preserve and upon it had raised onions at a profit in some cases of $100 an acre. Mr. H. M. Wilson, U. S. Geological Survey, mentioned as another financial asset the production of peat from the swamp country. In view of the increasing availability of peat as fuel this item should be of considerable importance.

The relation of the drainage problem to the existing branches in the government was discussed by officers in those various departments. Hon. Jas. R. Garfield, Secretary of the Interior, outlined the policy of the administration in preserving the natural resources of the country and stated that a national supervision of the work of drainage would be in line with the work of irrigation and forest preservation which is now in full swing. Mr. Gifford Pinchot, Chief Forester of the United States, Mr. F. H. Newell, Director of the Reclamation Service, and Mr. G. O. Smith, Director, U. S. Geological Survey, all expressed their approval of the objects of the association and their hope that the departments under their control would be able to cooperate in any scheme that might be evolved.

Maj. J. A. Dapray, U. S. Army, presented the rather novel view that any reclamation of coast marshes would only be undertaken after a consultation with that branch of the War Department in charge of the coast defenses. Our present coast defenses are based on the existence of certain swampy lands along our coast where it is supposed that a hostile army could not land. The reclamation of these areas would necessarily require a readjustment of the whole scheme of defense.

The methods by which an extensive system of land drainage shall be carried on are still the subject of much discussion. There are in several of the states laws which provide on a small scale for the carrying on of drainage projects. The federal government has, in the Agricultural Department, a Bureau of Drainage Investigations which for the past few years has been making a study of the subject, principally, however, from the farmer's standpoint, but partially with a view to aiding the various state or subsidiary governments in any drainage project upon which they may desire information. It is thought, however, by the members of the National Drainage Association that the time has come when the federal government, to protect the lives and health of its citizens and to enhance the value of the wet and worthless tracts in this country, must undertake this work of drainage directly. The exact manner in which the government can do this is a matter for the constitutional lawyer. The Constitution of the United States gives the federal government no rights of reclamation over private or state owned property and the most of the swamp lands of the country have been ceded from the general government either to states or individuals. Senator Newlands of Nevada in a speech before the Congress claimed that the United States had the right to reclaim swamps under the interstate commerce clause of the constitution, on the ground that swamps are generally found on the lower reaches of insufficiently controlled navigable rivers for the maintenance of which the federal government is responsible. Another claim made was that the health of the people is a matter of public policy for which the whole country is responsible; that the draining of a mosquito ridden swamp is as much the business of the authorities at Washington as aid to the fever stricken inhabitants of southern cities during a yellow fever epidemic.

Several bills authorizing the government to proceed in this matter have been before Congress, but none meet with the entire approval of the members of the Drainage Association. The scheme most favored is modeled after the Newlands Irrigation act in that the settlers on reclaimed land are to pay back to the United States in ten annual payments the cost of reclamation; the only difference being that the irrigation work is being carried out mainly on government land whereas land to be drained is for the most part under state or individual ownership. The association, however, expressed no formal approval of any measure, preferring rather to present the case to Congressmen individually and await such action as Congress may see fit.

There is to be a meeting in Washington in May, 1908, to which the President has called the various state governments to discuss the conservation of our national resources. At this meeting it is expected that delegates from the drainage congress will be able to interest many officials upon whose action the future of the project depends. The next meeting of the Congress will therefore be held in Washington next May before the regular December meeting.

The following officers were elected for the ensuing year: President, Hon. N. P. Broward, Governor of Florida; 1st vice-president, Dr. James Mosley, Delaware; 2d vice-president, W. S. Braddock, Wisconsin, and treasurer, Mr. B. H. Griswold, Maryland. A secretary was not elected at this meeting, but Dr. Wm. N. Hill of Baltimore acted as such during the convention.

MUNICIPAL DOCKS for Newark, N. J., have been authorized by State legislation, a general scheme has been approved by referendum vote, and plans for such docks, located on a canal leading out of Newark Bay, have been prepared by Mr. James Owen, M. Am. Soc. C. E., of Newark, and submitted to Mr Morris R. Sherrerd, M. Am. Soc. C. E., Chief Engineer of the Board of Street and Water Commissioners of Newark. An expenditure of $1,000,000 has been authorized, and the legislative act becomes operative on Jan. 1, 1908. The general scheme is being studied by the Board named, in conjunction with Mr. Owen's plans and with the work of government engineers. It is expected that the city will acquire the needed real estate and do a part of the work within the next two years, in order that it may soon begin to receive revenue. The plan proposed by Mr. Owen includes a canal 1,000 ft. wide and 30 ft. deep in the center, on each side of which would be slips and docks. There would also be coal and bridge piers at the inner end of the canal and transfer slips and docks on the river front. The piers on the sides of the canal would be 150 ft. wide and the slips would be 250 × 1,200 ft. in plan. The piers on the bay front would be 150 × 1,500 ft. in plan, and the coal piers mentioned would be 1,500 ft. long. The total length of pier frontage thus obtained would be about 115,000 ft., or some 22 miles. The total area affected by the improvement would be about one by three miles. The Pennsylvania R. R., Lehigh Valley R. R. and Central R. R. of New Jersey, all have lines immediately adjacent to the proposed site, and tracks communicating with the piers and docks are included in the plan, with large transfer yards and the two assembly yards. Provision is also made for both highway and trolley freight service. It is hoped that deep-water docks on the bay end of the tract can be provided soon, and also a shallow canal which would be subsequently deepened as required. It is also hoped that the Federal Government will provide a deep-water channel from Kill von Kull to the dock site. The distance is about a mile. The completion of the scheme involves a considerable amount of meadow drainage and improvement, and it is thought possible that some of this could be effected in conjunction with the Federal Government if plans for embarking on drainage work by the general government, now under consideration at various quarters, are consummated. We are indebted to Messrs. Sherrerd and Owen for the information given.

HYDRAULIC DREDGE USED ON THE NEW YORK STATE BARGE CANAL.

By EMILE LOW,* M. Am. Soc. C. E.

The center line of the New York State Barge Canal in Contract No. 4, Residency No. 5, starts at the mouth of Fish Creek, where it empties into Oneida Lake, and follows the valley of this stream and its tributary, Wood Creek, for about five miles. The spoil banks for depositing the excavated material lie on either side of the canal prism. The depth of cutting at Oneida Lake is about 15 ft., gradually increasing to 25 ft. at the eastern end of the contract.

FIG. 1. HYDRAULIC DREDGE "ONEIDA" AT WORK ON NEW YORK STATE BARGE CANAL NEAR ONEIDA LAKE.
Empire Engineering Corporation, Contractor; Lindon W. Bates, Designer.

To excavate this channel, the Empire Engineering Corporation, holder of the contract, has in operation the special dredge here described, which was built after the design of the president of the company, Mr. Lindon W. Bates.

In designing the dredge it was known that it would be necessary to take it through the locks of the present Erie canal so the size of these locks virtually fixed the following dimensions of the steel hull: Length over all, 97 ft.; extreme beam, 17.5 ft.; molded depth to deck, 10 ft.; and light draft 5.5 ft. This hull is a huge box with the bilges slightly rounded off. The frames are of 3 × 3-in. × 6.1 lb. angles, in one piece from keel to deck and spaced 21 in. c. to c. The reverse frames, of 2¼ × 2¼-in. × 3.6-lb. angles, follow the tops of the 10 × ⅝-in. floor plates, every alternate one extending to deck and the intermediate one extending to the lower stringers. There is a continuous center keelson, with intercostal keelsons at the main engine foundations. Additional bracing is provided about the engines. The deck beams are plain 4½ × 3-in. × 9.1-lb. angles one on every frame, with a 3-in. crown in the center of the vessel. The shell plating is of ⅝-in. metal.

The suction pipes are two in number and extend, one on each side of the hull, from the centrifugal pump aft to the cutter forward. They are 19¼-in. diam. inside. Two cast iron breech pipes are bolted to the pump, which connect with the intermediate length of pipe made of steel plates with thick angle steel flanges turned true. These pipes are made of No. 9 B. W. G. At their forward ends they are connected to two Bates curved telescopic joints. The moving interior portions of these joints are bolted to the upper end of the ladders, which are suspended by means of heavy brackets from trunnions whose axis is also the axis of the telescopic joint.

The two movable suction pipes or suction ladders are built up pipes having each an area of 291 sq. ins. They are built up of plates and angles with bearing on top for carrying the cutter shafts. At the lower end of these ladders are attached the cutter heads (Fig. 2) which are 5 ft. 6 ins. in diameter and 3 ft. 8 ins. high. They are mounted around and concentrically with the end of the suction pipes, and have each 12 knives of manganese steel, ⅞-in. thick. The cutters and ladders are handled by blocks and falls of suitable dimensions, five sheaves in each block for ¾ in. steel wire rope. The hoisting speed is about 10 ft. per minute.

To operate the cutters there are two independent compound vertical reversing engines, placed back to back and located in the forward engine room. When running at 220 rev. per min. they indicate 200 HP. In the same engine room is located a service pump, electric plant and blower engine. The service pump is used as an auxiliary feed pump and discharges to boilers, ladders and cutter head bearings, fire service pipes and over board. On the suction head it is connected to hot well, sea, bilges and settling tank.

In the after engine room are located one set of triple expansion engines, connected direct to centrifugal pump. This set of engines develops 750 HP., when running at 165 rev. per min., cutting off steam in the HP. cylinder at about 6-10 of the stroke. The HP. cylinder is 17 in. diam.; the IP. 25 in., and the LP. 42 in., with a common stroke of 24 in.

The centrifugal pump has two suctions with a total area equal to a 19¼-in. diam. pipe and one discharge of 26 in. diam. The pump casting is made in five pieces, throat piece containing a steel knife, two upper and two lower segments of the pump case. The runner is cast steel, and 6 ft. 6 ins. in diameter.

Steam is generated from two water tube boilers working at 200 lbs. pressure and having a combined heating surface of 3,750 sq. ft. and a grate area of 95 sq. ft. To operate the spuds a horizontal engine, having two cylinders 6½ × 8 in. is used. The engine has reverse link motion, compound geared, and arranged for a rope speed of 40 ft. per minute, using a flat rope 3 × ⅝ in. The reels are 18 in. diam., set up frictionally, and provided with band brake.

On the forward deck is mounted a two-cylinder steam winch, 8¼ × 10 in., with rope speed of 60 ft. per min. on the warping drum. There are two 18 in. diam. and 38 in. face drums, to hold 1000 ft. of ¾-in. diam. wire rope in four layers, and also two drums, 24 in. diam., 16 in. face, to coal about 400 ft. of ¾-in. rope in three layers. The discharge pipe is carried on pontoons, there being 16 line and one terminal pontoon; on the latter is built a workshop, with forge and equipment to make needed repairs.

The dredge described is one of two built by the New York Shipbuilding Co. of Camden, N. J., for the Empire Engineering Corporation. The other dredge is an exact duplicate and is used by this firm on Contract No. 4, near the Montezuma swamps in Central New York. The dredges were assembled at the shipbuilding yards, taken down, and then erected at the working points. The dredge "Oneida" was erected during the summer of 1906, and was put in commission on October 3 of that year and worked until the early part of the following December, when an extreme "spell" of cold weather compelled suspension of operations.

It may be stated here that the dredge when in working order is not altogether stable, and it was necessary to add two pontoons each 6 ft. wide, one on either side to insure proper stability. These pontoons are built so as to be easily attached and detached.

In the beginning of October, 1906, the dredge worked one shift daily of 8 hrs. each, later two shifts of 8 hrs. each, and in November, 1906, three shifts of 8 hrs. each, or during the entire 24 hrs. of each day. It was in charge of a chief engineer, assisted by a chief operator, and the working force for one 8-hr. shift was as follows:

1 Operator	at $100.00	per month	
1 Engineer	at 100.00	"	
1 Engineer	at 80.00	"	
3 Firemen	at 70.00	"	each
1 Spudman	at 60.00	"	
1 Oiler	at 50.00	"	
4 Deckhands	50.00	"	each

Besides this force there is another gang in charge of shifting the discharge pipe, and repairing the levees surrounding the spoil banks, in which the excavated material from the canal prism is discharged.

There is also a night watchman and engineer of a gasoline yacht or launch, which acts as a tender to the dredge, towing fuel scow and other pertinent work.

Could the methods likely to be used have been foreseen, radical changes in the location of the canal might have been made to great advantage, as in the portions of the canal where it was coincident with Wood Creek, much difficulty was experienced in the construction of levees, the many windings of the stream requiring a number of pile bridges over which to transport the excavator, which was used in building these.

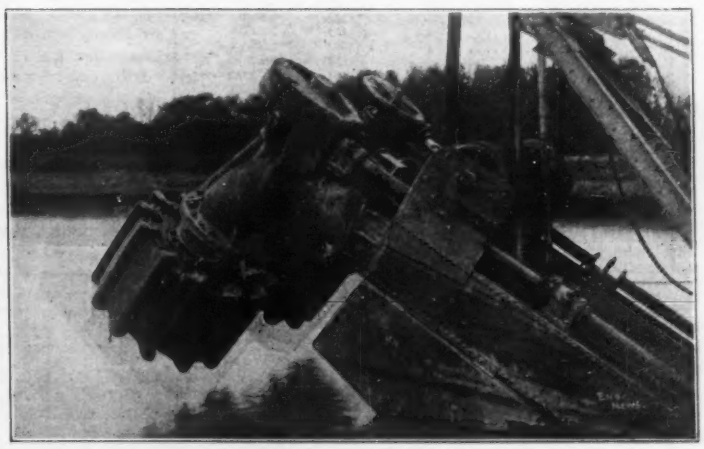


FIG. 2. CUTTERS OF HYDRAULIC DREDGE "ONEIDA."

As high as 10,000 cu. yds. of quicksand has been pumped in 24 hrs. On contract No. 5, near Montezuma swamps, outputs of 12,000, 14,000 and 17,000 cu. yds. in 24 hrs. have been realized.

The accompanying tables give the itemized costs for labor employed in operating the dredge "Oneida" during the months of October and

*291 Ashland Ave., Buffalo, N. Y.

November, 1906. During the spring of 1907, oil for coal was substituted, and oil is now being burned under the boilers.

NEW YORK STATE BARGE CANAL.

Middle Division. Residency No. 5. Monthly statement of force employed by Empire Engineering Corporation, Contractor Hydraulic Excavation. Contract No. 4.

DREDGE "ONEIDA."

October, 1906.	No. of days.	Rate.	Amount.
Chief Engineer	25	$150.00	$138.88
Chief Operator	25	135.00	125.00
Engineer	43	100.00	159.26
Engineer	43	80.00	127.41
Operator	4	130.00	19.26
Operator	39	100.00	144.44
Fireman	129	70.00	334.44
Spudman	43	60.00	95.55
Oiler	39	50.00	72.22
Deckhand	172	50.00	318.51
Foreman	20⅝	2.00	41.25
Laborer	220½	1.60	352.80
			$1,929.02

Cubic yards dredged = 38,173 = .505 cents per cu. yd.

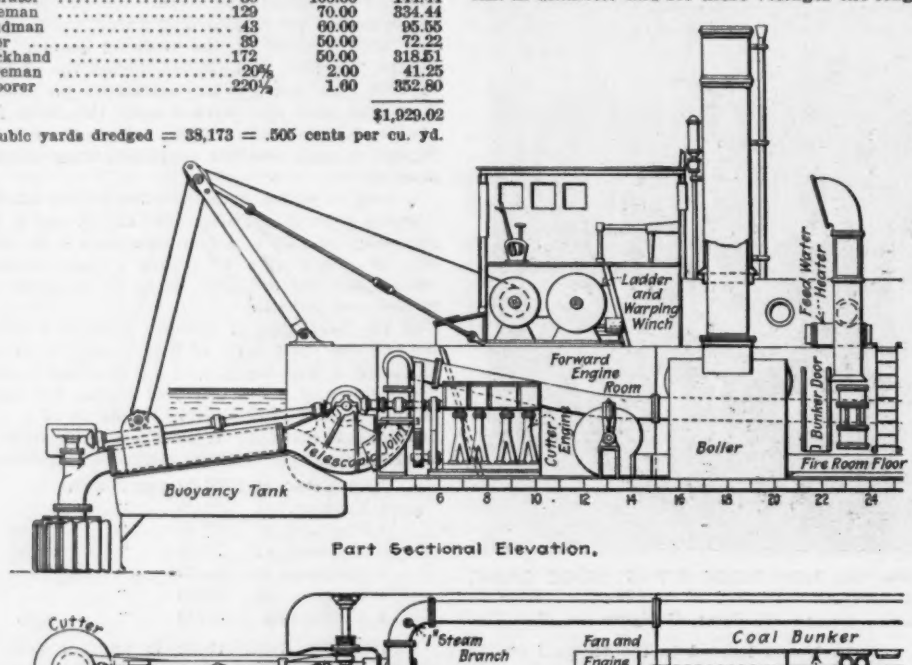


FIG. 3. PLAN AND ELEVATION OF FRONT END OF DREDGE "ONEIDA."

Only about two weeks were engaged in actual dredging, the other two in repairs.

November, 1906.	No. of days.	Rate.	Amount.
1 Chief Engineer	30	$150.00	$150.00
1 Chief Operator	30	135.00	135.00
3 Engineers	86	100.00	286.67
3 Engineers	86	80.00	229.33
3 Operators	86	100.00	286.67
9 Firemen	258	70.00	602.00
3 Spudmen	86	60.00	172.00
3 Oilers	86	50.00	143.33
12 Deckhands	344	50.00	573.33
1 Night watchman	30	1.60	48.00
1 Foreman	34¼	3.00	102.75
1 Foreman	37½	2.00	75.50
Laborers	1,056½	1.60	1,690.40
1 Engineer, Tug	30	80.00	80.00
			$4,574.98

Cubic yards dredged = 144,882 = .308 cents per cu. yd.

The item of "Laborers" was mainly in connection with the handling of the discharge pipe and the repairing of the levees or dykes built by excavating machine, to retain the pumped material.

The wages paid are in accordance with agreements made yearly between the various International Brotherhoods and the Dredge Owners.

OPEN TRAILER CARS to lessen the dangers of contracting pneumonia in Chicago have been recommended by Dr. W. A. Evans, Commissioner of Health of that city. Speaking of the delay in "advent of the 'pneumonia season,'" this year, Dr. Evans says (Chicago Health Bulletin, Nov. 23, 1907):

The weather has contributed to this favorable condition wherein it has permitted people to live out of doors more than is usual at this season, a fact which leads to the reflection that if people would live more in the open air and less in overheated and ill-ventilated quarters, pneumonia would be much less prevalent than it is during the fall and winter months.

The attention of the department has recently been directed to the ventilation of street cars and, after due consideration of the conditions, the commissioner has decided to recommend to the traction companies that an open trailer be attached to each train for the accommodation of people who recognize that danger lurks in the air of closed, unventilated cars and who realize the healthful effects of the open air.

A MERCURY-VAPOR LAMP WITH A QUARTZ TUBE.

In "Electrical Engineering" of London, issue of Oct. 10, 1907, an abstract is given of a paper, before the Electrotecknischer Verein, in which a new type of mercury vapor lamp is described. Fundamentally the glass tube of the Cooper-Hewitt lamp is replaced by one of quartz, with a great reduction of dimensions. The ordinary glass tube for service, 110 volts, is 21 ins. long, and for 220 volts is 45 ins., both being of 1-in. diameter. The quartz tubes are only some 0.4 ins. in diameter and for these voltages the lengths are respectively about 3.2 and 6.3 ins. It has therefore been possible to arrange the parts in enclosing apparatus so that the assembled lamps closely resemble ordinary enclosed arcs. It is stated that the author of the paper exhibited one of these lamps before his audience. On first starting, the light filled the whole tube, as in the ordinary type, but this glow discharge changed and presented a filament-like appearance, while the color of the light emitted changed from greenish-blue to a white. However, red rays were still much fewer than with sunlight and color values were much distorted. The curve, Fig. 1, was exhibited to indicate the performance of a given mercury arc in a quartz tube. In the ordinary glass tube the power consumption reaches a minimum at about 0.6 watts per c. p. and if more power be supplied the c. p. increases at a slower rate than the increase in watts and the efficiency therefore increases. It was found, as shown in Fig. 1, that the watts per c. p. reaches a maximum at about 1.0. At this point the glass begins to soften. By using quartz tubes, on account of a very high melting point, it is possible to attain much greater arc temperatures, and it was found that the efficiency was greatly improved, as shown in the curve. At the points of very high efficiency the pressure of the mercury vapor inside rose as high as one atmosphere above atmospheric pressure. The following table is derived from a test made at the Physikalisch-Technische Reichsanstalt:

Volts at the tube terminals (without resistance in series).	Current (amps.).	Candle-power. Horizontal. At right angles to the tube.	Candle-power. Mean spherical.	Watts per c. p. Horizontal.	Watts per c. p. Mean spherical.
174	4.2	3,090	2,690	0.24	0.27
197	4.2	3,580	3,110	0.23	0.27

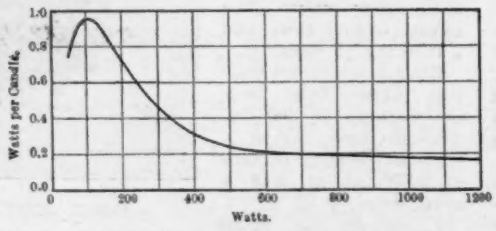


Fig. 1. Efficiency-Specific Consumption Curve of Mercury Vapor Lamp with Quartz Tube.

These values of watts per c. p. are to be somewhat increased by the action of reflectors and the enclosing globes of the commercial form of lamp. The resistance of the quartz tube varies with the interior pressure temperatures. At first the tube absorbs only 20 or 30 volts and if only normal current were allowed to pass the high temperature and pressure could not be attained. The starting resistance is designed so that the starting current is double that when operating normally. After a few minutes it may be reduced as the voltage rises. The temperature and voltage curve of the tube was measured by thermo-couples up to 1,700° C., the melting point of the thermo-couples used. This curve was a straight line up to this limit, which point had a corresponding voltage of 60. The normal operating voltage was 180 and on the assumption that the curve proceeds as a straight line a temperature of about 6,000° C. was estimated in normal operation.

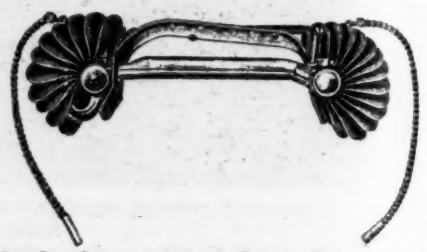


Fig. 2. Arrangement of Quartz Tube and Heat Radiators for Mercury Vapor Lamp.

The actual design of the tube is shown in Fig. 2. At each end is a bulb, containing a mercury electrode, with fan-shaped metal blades to assist in radiating the excessive heat. No condensing chambers are employed as in the Cooper-Hewitt type. To start the lamp the tube is turned about on its axis by a shunt electro magnet so that a thread of mercury flows from one bulb to the other. This short circuits the magnet circuit and causes the tube to return to normal position, breaking the mercury stream and starting the arc. The only other auxiliary apparatus is the series resistance already mentioned.

The author of the paper stated that the cost of a 220-volt lamp would be about $50. The lamp will be made and marketed by the "Quarzlampen Gesellschaft" of Pankow, Germany, and it is expected that lamps will be placed on the market this year.

LINING DITCHES AND RESERVOIRS TO PREVENT SEEPAGE LOSSES.

A progress report on studies of irrigation ditch and reservoir linings has recently been made, in the form of a bulletin (No. 188) issued by the University of California.* The bulletin consists of a brief introduction by Mr. Elwood Mead, M. Am. Soc. C. E., and a detailed account of investigations and experiments by Mr. B. A. Etcheverry. It includes both descriptions of actual ditch linings and descriptive accounts of a number of experimental linings.

In his introduction Mr. Mead calls attention to the fact that a large number of measurements made by the U. S. Office of Experiment Stations show an average loss on main canals of about 1% for each mile that water is carried; on laterals the loss amounted to between 11% and 12% per mile; while on some California canals the loss in a single mile was 64%.

*College of Agriculture, Agricultural Experiment Station, Berkeley, Cal.

Attention is also called to the serious seepage losses from small reservoirs, for which the cost of lining by expensive methods would be prohibitive.

The requisites for a good ditch lining, as stated by Mr. Etcheverry, are, that it should stop seepage, prevent small animals from burrowing through the banks, prevent vegetation and also scouring, and not easily be damaged by either the weather or cattle.

The use of linings for irrigation ditches has thus far been confined chiefly to Southern California. A number of types of such linings are described in the bulletin. About 1882 the Ontario Colony Enterprise paved a canal 5 ft. wide at the bottom, 6 ft. at the top and 2½ ft. deep, with stone laid in hydraulic lime mortar, this paving then being plastered with cement mortar. The lining was 8 ins. thick and cost about 60 cts. per lin. ft., or 6 cts. per sq. ft. Chinese labor was employed at $1.25 a day, and lime cost only $1 per bbl. Similar linings, with modifications in detail, have been used elsewhere in the vicinity.

Cement concrete has been used for lining ditches south of Los Angeles. The Anaheim Water Co. has used concrete ranging from 4 ins. in thickness for a main canal to 2 ins. for smaller laterals. Wooden forms were used, as shown by the accompanying sketches. The concrete was 1 part cement and 7 parts coarse gravel of varying size. For a main canal, with a bottom width of 5 ft. and a lining 4 ins. thick, the cost per sq. ft. was about 10½ cts. In this case cement cost $2.85 per bbl., gravel 60 cts. per cu. yd., labor for shaping the ditch $1.75 and for concrete $2 and for foreman $3 per day. Lining 2 ins. thick for laterals cost 6 cts. per sq. ft.

Cement mortar has probably been more extensively used for lining irrigation ditches in Southern California "than all the other methods combined," and "has proven very efficient." This method has been employed near Riverside by the Gage Canal Co., the Riverside Water Co., and the Jurupa Co. The lining varies from ½ to 1 in. in thickness. The cost of such a lining, composed of 1 part good Portland cement and 4 parts clean sharp sand, is given as about 4 cts. per sq. ft., including the preparation of the slopes and bottom. The thickness of the lining put in at this figure was ¾-in.

Heavy road oil has been used to line a canal at Lemoore, Kings County, Cal., owned by the Lemoore Canal & Irrigation Co. In November, 1905, oil was applied on a stretch of canal 20 ft. wide, about 1 ft. deep and 1½ miles long. The oil was a crude petroleum containing a large percentage of asphaltum, and was so thick that when cold it would not run freely. It has a specific gravity of 11½ on the Beaumé scale. The oil was applied at the rate of 1½ gals. per sq. yd. It was first heated, then applied with a road sprinkler. The oil was harrowed in thoroughly, the soil being sandy. It appears that the chief reason for treating this canal as described was to prevent the growth of vegetation. Seven months after the oil was applied, or in May, 1906, "there was no vegetation in this part of the canal, while other parts of this same canal which had received no oil and had been cleaned two weeks previously showed a vigorous growth of vegetation." The oil has had no bad effect upon the crops.

The application of crude oil to reservoir embankments is briefly described in the bulletin. The results achieved give promise of the usefulness of oil to prevent seepage and also to prevent erosion.

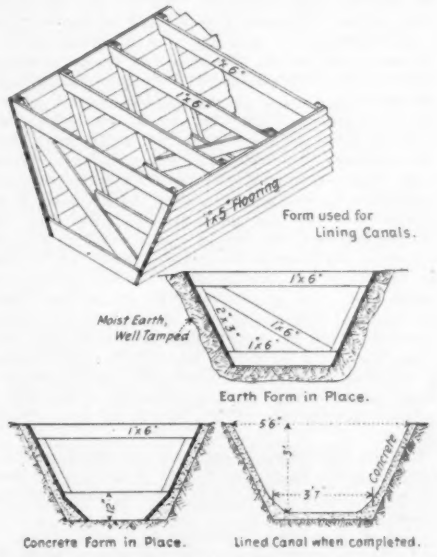
No examples of the use of clay puddle for lining reservoir ditches could be found by Mr. Etcheverry. Where clay could be found close at hand, he is of the opinion that its use for stopping seepage "would be very satisfactory and efficient." He also suggests the use of cattle, or preferably sheep, for working the puddle. He estimates that for a lining 4 to 6 ins. thick the cost of clay puddle would not exceed 1 to 1½ cts. per sq. ft.

In order to ascertain the relative efficiency of various linings as regards seepage prevention, 12 ditches were dug and some were lined with different materials and some were left unlined. Each ditch was 2½ ft. deep, 2 ft. wide on the bottom, and had side and end slopes of 1½ on 1, a bottom length of 42½ ft. and a top length of 50 ft. The ditches were 14 ft. c. to c., giving a top width of 4½ ft. for the separating bank. The site for the experimental ditches not being perfectly level, the land was irrigated and plowed and the earth removed as necessary to bring to level, Fresno scrapers being used for the purpose. Each unlined or earth ditch had an adjacent lined ditch on each side. The methods of lining and of observation and other details of the tests may be given in full as follows, the matter quoted forming the concluding portion of the bulletin:

METHOD OF LINING.

No. 1. The oil was heated to a temperature of about 180° F., at which temperature it would flow easily. This heated oil was mixed with the gravel in the proportion of 1 part of oil to 8 parts of gravel by volume. The mixing was done with rakes and the mixture was very uniform. The sides were lined first.

Pieces of timber 3½ ins. thick were placed on the slopes at right angles to the axis of the ditch, about every 10 ft. The oil-gravel mixture was carried in wheel-barrows and dumped on the slopes between these



Methods Employed in Lining Anaheim Water Co.'s Irrigation Canal with Concrete.

timbers. A straight edge about 12 ft. long, extending from one timber to the other and worked up and down the slope, regulated the thickness of the lining to 3½ ins. The mixture was tamped while being placed in position.

No. 3. This ditch was lined in exactly the same manner. The mixture used contained 1 part of heavy Bakersfield oil to 6 parts of gravel. The thickness of the lining was only 2½ ins.; the slope timbers being therefore 2½ ins. thick instead of 3½ ins. thick, as for No. 1.

No. 4. This ditch was lined with the same heavy oil. The oil was heated to a temperature of 180° F., and was sprinkled or poured on the slopes with a 3-gal. watering pot, with the rose sprinkler flattened so as to throw a flat stream or sheet of oil on the side of the ditch. The oil was applied mostly on the top of the slope, and as it ran down the slope it was gradually absorbed by the ground—some of it reaching the bottom. An excess of oil accumulating at the bottom was dragged up the slopes by using a stick about 8 ft. in length to which a 2-ft. piece of timber was nailed, at right angles, at one end, and to this piece was nailed a couple of sacks to be used as a mop. If the oil is not applied in large quantities at once, but instead several successive light applications are made, it will not be found necessary to use this mop.

The oil was not raked in; the object sought for was to have the oil form a thoroughly saturated crust; while if it was raked or plowed in, the oil might have been disseminated through too thick a layer to form a water-tight crust.

No. 6. The sixth ditch was sprinkled with lighter oil in exactly the same manner as the fourth ditch, using 2½ gals. per sq. yd.

No. 7. The seventh ditch was lined with clay puddle. The clay was difficult to obtain, having to be hauled about three miles, which made it very costly. The clay contained fine silt and sand. It was sprinkled with water, and when soft was hauled in wheel-barrows and applied in the same manner as the oil-gravel mixture. The thickness of the lining was 3½ ins.

No. 9. The ninth ditch was lined with cement mortar, composed of 1 part of cement to 5 parts of gravel. The lining being 1 in. thick, the scantlings or guides placed on the slopes were only 1 in. thick.

No. 10. This ditch was lined with cement concrete 2½ ins. thick, composed of 1 part of cement to 7 parts of gravel and crushed rock, in equal quantities.

No. 12. The twelfth ditch was lined with cement lime concrete 2½ ins. thick, composed of ⅜-part of cement, ⅛-part of lime, and 7 parts of gravel and crushed rock in equal quantities.

Before lining with cement mortar, cement concrete, and cement lime concrete, the slopes and bed of the ditches were well wetted by sprinkling. These three linings were also kept wet for several days after the construction.

The oil ditches had been finished about ten days before the water was turned into them. This was necessary for the oil to soak in well and also for the lighter volatile parts of the oil to evaporate. The water was first turned in on July 23, 1906, and observations were then started.

METHOD OF OBSERVATION.

The ditches were filled each morning to a depth of 2 ft. (approximately), the measurements being taken as soon as filled. Measurements were again taken late in the afternoon and also the next morning before refilling the ditches. The instrument used to take the measurements consisted of a wooden post, 2 ins. by 3 ins., which was driven firmly in each ditch at the south end. The top of the post was about 3 ft. from the bottom of the ditch. A right-angle screw hook, with the shorter arm filed to a point, was screwed into the post. The depth from the bottom of the ditch to the end of the hook was 2 ft. This served as a guide in filling the ditch, each ditch being filled as nearly as possible up to this hook. For an exact measurement a piece of steel about 5 ins. long, ⅛-in. thick, and ¾-in. wide, was screwed at the top of the post and at right angles to it. This piece of steel projected about 2 ins. beyond the post and its upper edge was beveled. This edge was the index from which the measurements were taken. The measurements being taken with a plumb-bob attached to a steel tape, the steel tape was placed next to the index and the plumb-bob lowered until the point of the bob touched the water. Accurate measurements could thus be taken to .005-ft.

The evaporation was determined by means of a galvanized iron tank placed at the north end of the ditches, between ditches No. 6 and No. 7. Measurements were taken in the morning and in the afternoon in the same manner as for the ditches.

From the observations taken beginning with the 23d and extending until the 28th of July, it was found that the lining of ditches No. 1 and No. 3 was entirely unsatisfactory, as the seepage in them was larger than in the earth ditches with no lining. It is probable that the water percolated through this lining and was carried away through gopher and squirrel holes under the lining. In the earth ditches gopher and squirrel holes were found, but could be stopped; but this oil and gravel mixture had sufficient strength not to break through where the holes were, and they could not be discovered.

From the observations during these few days it was found that the seepage in all four earth ditches was almost identical, so it was decided to sprinkle oil on two of these earth ditches, using in both cases less oil than was used on ditch No. 4.

The gravel-oil mixture was removed from No. 1 and this ditch was used as an earth ditch. Ditch No. 3 was not changed; measurements on this ditch were continued, but it did not improve.

The ditches after July 28 were allowed to dry and after the changes were made were in the following order:

NEW ORDER OF DITCHES.

No. 1. Earth (no lining).
No. 2. Heavy oil sprinkled, 2½ gals. per sq. yd.
No. 3. Heavy oil and gravel, 1 part of oil to 6 parts of gravel (2½ ins. thick).
No. 4. Heavy oil sprinkled, 3⅜ gals. per sq. yd.
No. 5. Earth (no lining).
No. 6. Thin oil, 2½ gals. per sq. yd.
No. 7. Puddled clay, 3½ ins. thick.
No. 8. Heavy oil sprinkled, 3⅜ gals. per sq. yd.
No. 9. Cement mortar, 1 in. thick.
No. 10. Cement concrete, 2½ ins. thick.
No. 11. Earth (no lining).
No. 12. Cement lime concrete, 2½ ins. thick.

The water was again turned into the ditches on Aug. 6, but because of a serious break in the main canal of the irrigation system, the water could not be obtained again until Aug. 28. Observations were again begun and were taken until Sept. 10, a period of 14 days.

For the first four days the results were not very uniform; probably because some of the ditches had held water much better than the others during the interval when no water was available for filling them. The rates of percolation per hour given in Table I. are the rates of percolation for the last ten days. This rate of percolation is computed from the readings taken each day.

The seepage and evaporation for each ditch, from the time the ditch is filled to the time when the level of the water is measured next morning just before filling, give the total seepage and evaporation for that time. Subtracting from this the loss in level due to evaporation gives the loss due to seepage. This quantity divided by the number of hours in which this loss occurred gives the rate of percolation or seepage in feet per hour.

The rates of percolation for the three earth ditches were very nearly equal. However, in comparing the seepage from the lined ditches with the seepage from the earth ditches, the relation is obtained by making the comparison with the nearest earth ditch.

The efficiency of a ditch is the ratio between the rate of percolation for the earth ditch and the rate of percolation for the adjacent lined ditch; or, efficiency = rate of percolation for earth ditch over the rate of percolation for lined ditch. The larger this ratio the more efficient or water-tight is the lining.

From the mean sinkage or mean percolation of the several ditches is computed the percentage of saving due to the lining in each case. This saving indicates the probable percentage of water saved from the loss which would take place if the ditch was not lined. The experimental cost per square foot of the lining is the actual cost at which the work was done. It does not include the cost of finishing and preparing the ditch for the lining. This cost was about 1 ct. per sq. ft.

The actual cost per square foot for work on a larger scale would naturally be somewhat smaller. The cost given in Table II. is estimated from similar work in existence and agrees with the cost in the examples mentioned in the first part of this paper. For oil lining the cost would depend largely on the price of oil. The price assumed in preparing the table was 2 cts. a gal. for the oil and 1 ct. a gal. to apply it. For cement concrete or cement mortar it is customary to prepare the ditch and finish it carefully. The bottom and side slopes are made even and regular. The cost of finishing on a large scale for first-class work would probably be less than the actual cost on the experimental ditches and would probably not exceed ¾-ct. per sq. ft.

For oil and puddle linings, it would not be necessary to finish the ditch so carefully. The removal of weeds may be the only preparation necessary.

MATERIALS AND COST.

CEMENT.—California Portland cement (Standard Brand), at $3 a bbl. in Modesto.

LIME.—Roach Harbor lime, at $2.50 a bbl. in Modesto.

BROKEN STONE.—Obtained from Folsom, Cal., at $3 a cu. yd. in Modesto.

GRAVEL—Clean river sand, varying from 1-in. pebbles to coarse sand obtained from Dry Creek, about 3 miles from the site of the experiments, at 10 cts. a cu. yd. The charge for hauling to the site was $1.50 per cu. yd.

PUDDLE.—Difficult to obtain. The only clay available was about 3 miles from the site, and it had to be dug with picks. The charge for loading and hauling was about $1.50 per cu. yd.

HEAVY OIL.—Natural crude mineral oil (10½° to 11½° Beaumé), from the Sunset District near Bakersfield, Cal., containing not less than 60% to 80% by weight of "D" grade asphalt. The percentage of asphalt is not always dependent on the specific gravity. With two oils of the same gravity, one may contain 80% of asphalt and the other none. The oil was obtained at 85 cts. a bbl. (42 gals.) delivered on the site.

LIGHT OIL.—Natural mineral oil (16° gravity) containing about 35% to 40% of "D" grade asphaltum. The price was 85 cts. a bbl.

COST OF LABOR.—All labor cost $2.50 for an eight-hour day; one foreman at $5 for an eight-hour day, and a teamster with team $4.50 per day.

RESULTS OF OBSERVATIONS AND EXPERIMENTS.

A study of Table II. shows that cement concrete 3 ins. thick stopped 86.4% of the seepage which occurred in an earth ditch of the same material. This percentage would probably have been larger had the earth been more porous; for this would make the loss in earth ditches greater, while the loss from the cement concrete ditch would probably not have been increased. This is true also, but probably not to the same extent, for the other lined ditches. However, it is quite safe to believe that in more porous or open soil the percentage saved by lining would be greater than shown in the table.

While there is no doubt but that cement concrete is the most efficient as regards seepage, it is also the most expensive, being more than six times the cost of the heavy oil lining (3⅜ gals. per sq. yd.), which saves 50.4% of the water which would seep were the ditch not lined. This saving with the concrete ditch is 86.6% or 1¾ times as large. Where water is very valuable there is no doubt but that the concrete ditch is more permanent and economical. But where the water is not so scarce and a little waste will do no damage, the expense of lining the ditch with oil may be justified, while a more expensive lining would be impracticable.

The question will come up: "Is it economical to use oil on a ditch to save 50% or less of the water which is being lost in ditches not lined?" Perhaps there is a great deal of water, and in many irrigated districts the waste of water seeping from the canals and laterals while large is small compared with the larger waste due to over-irrigating the fields and to poor methods of irrigation. These conditions will no doubt better themselves as California becomes more settled and the water is more economically used and more valuable. But even under the present conditions the advantage of lining a canal is not alone the decrease in seepage; other factors should be considered, as mentioned in the first part of this paper. (1) The prevention of growth of vegetation is an important item and is quite an expense, when in most cases the ditch or lateral must be cleaned out several times during an irrigation season. (2) The resistance to scouring, on which depends the velocity which the water can be given. (3) The prevention of squirrels and gophers from burrowing into the banks and bottom of ditches.

That oil will prevent vegetation and the burrowing of animals on the banks and bottom of the ditch is clearly shown by the example near Lemoore, previously mentioned.

That oil will prevent scouring to a great extent and will allow a much higher velocity of flow of water than the earth ditch may be expected, when we consider its resistance to wave action at the Ivanhoe Reservoir, and the resistance of oiled roads to cutting under the action of running water. This toughness of oil lining was also noticed in filling the experimental ditch each morning. When the water carried by the wooden flume discharged into each ditch through the gate it had a fall of at least 1 ft. It was difficult to prevent the sloping ends of the earth and puddle ditches from being badly cut up by the erosive force of the falling water. These ends had to be well protected with heavy canvas, and even so erosion could not be altogether prevented. The ditches lined with oil resisted the erosion and showed no scouring, although they were not protected with canvas.

A letter from the superintendent of the Modesto Irrigation District, dated Jan. 21, 1907, states that the ditches were examined by him after the recent heavy rainfalls. The banks of the earth ditches were badly washed where the water ran in; the clay puddle was slightly [illegible] but the oiled ditches showed absolutely no sign of wash. The oil linings are all hard and firm and scratch almost like concrete.

This resistance to erosion will permit in a saving of cross-sectional area due to the possibility of giving the water an increased velocity. The higher velocity will prevent the deposition of silt to a great extent and there will be a consequent decrease in the cost of operation and maintenance.

The puddle lining in the experiment showed a saving in seepage nearly equal to the heavy oil lining when 3⅜ gals. of oil per sq. yd. was used, and a greater saving than the other oil linings. This puddle lining whose thickness was 3½ ins. would, no doubt, if made thicker, be more efficient than any of the oil linings as regards seepage; but clay puddle when wet becomes very soft and will not resist the erosive force of the flowing water unless the velocity is very small. It will not prevent the growth of weeds. For these reasons it is probably not as efficient for canal linings as oil. But where clay is plentiful it would be preferable for reservoir lining. The slopes should, however, be protected against the erosive action of the waves by the use of cobblestones or other protection.

The use of oil in lighter quantities, while not very efficient in preventing seepage, will no doubt prevent the growth of vegetation, as illustrated by the example of the ditch near Lemoore. In this case only 1½ gals. per sq. yd. was used and this quantity has been sufficient to prevent vegetation.

Cement mortar plaster, so extensively used in Southern California, showed a saving in seepage water of 63%. Better results were expected, and it is probably safe to expect a greater saving where good work is done, especially where the work is constructed in cold weather. This lining had to be applied when the temperature in the field was probably 110° or over. The cement mortar was mixed in small quantity and quickly applied. As soon as the setting had started the lining was sprinkled and covered with wet canvas, but even with these precautions better work could be done in cooler weather.

This plaster, while very efficient and economical on small ditches, would not be of sufficient thickness and strength to be used on the larger canals and laterals of larger irrigation systems, where a thickness of from 2 to 4 ins. would no doubt be successful.

THE BATTERY TUNNEL UNDER THE EAST RIVER for the Brooklyn extension of the rapid transit subway of New York City has progressed so close to completion that an inaugural train was run through from Manhattan to Brooklyn on Nov. 27. Regular operation will be started probably shortly after the first of the new year, as far as Borough Hall, Brooklyn, and some months later as far as Flatbush.

TRAFFIC IMPROVEMENT STUDIES of the New York rapid-transit subway system have been made by Mr. B. J. Arnold for the Public Utilities Commission of New York City, and a preliminary report has just been ren-

TABLE I.—RATES OF PERCOLATION OR SEEPAGE IN TWELVE LINED AND UNLINED DITCHES.

No.	Kind of Lining.	Rate of percolation in inches per hour for ten consecutive days. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	Av. ins.	Efficiency ratios.
1	Earth, with no lining	.020	.032	.031	.034	.032	.033	.033	.031	.032	.032	.0329	.0329 / .0329 = 1.00
2	Heavy oil, 2½ gals. per sq. yd.	.026	.026	.025	.023	0.25	.022	.023	.024	.032	.032	.0239	.0329 / .0239 = 1.37
3	Heavy oil and gravel	....	....	....	...	...	...	...	...	...	...	....	.....
4	Heavy oil, 3⅜ gals. per sq. yd	.022	.020	.019	.018	.016	.016	.016	.017	.016	.016	.0176	.0355 / .0176 = 2.02
5	Earth, with no lining	.040	.036	.034	.034	.034	.035	.036	.033	.037	.036	.0355	.0355 / .0355 = 1.00
6	Thin oil	.035	.034	.032	.031	.032	.032	.033	.030	.034	.032	.0329	.0355 / .0329 = 1.08
7	Clay puddle	.021	.019	.018	.018	.018	.019	.017	.018	.019	.018	.0185	.0355 / .0185 = 1.78
8	Heavy oil, 3 gals. per sq. yd.	.024	.023	.024	.021	.024	.021	.021	.020	.022	.020	.0220	.0355 / .0220 = 1.50
9	Cement mortar, 1 in. thick	.014	.012	.013	.011	.012	.013	.011	.012	.011	.012	.0121	.0330 / .0121 = 2.73
10	Cement concrete, 3 ins. thick	.006	.005	.004	.004	.005	.004	.006	.004	.004	.004	.0046	.0330 / .0046 = 7.17
11	Earth, with no lining	.035	.036	.035	.034	.032	.036	.032	.032	.031	.030	.0330	.0330 / .0330 = 1.00
12	Cement lime concrete, 3 ins. thick	.010	.012	.009	.008	.011	.010	.009	.011	.012	.012	.0114	.0330 / .0114 = 2.90

Table II. Results of Experiments with Lined and Unlined Ditches.

Description of lining.	Av. mean sinkage per hr. in ft. excluding evaporation.	Efficiency ratios.	Per cent. saving.	Cost of lining, cts., per sq ft.* Experimental ditch.	Actual cost of lining.†
Cement concrete, 3 ins. thick	.0046	7.17	86.4	8.3	7.5
Cement lime concrete, 3 ins. thick	.0114	2.90	65.5	8.3	7.5
Cement mortar	.0121	2.73	63.3	3.88	3.25-3.50
Heavy oil, 3⅜ gals. per sq. yd	.0176	2.02	50.4	1.20	1.20
Heavy oil, 3⅜ gals. thick	.0185	1.78	47.8	3.90	1.20
Heavy oil, 3 gals. per sq. yd	.0220	1.50	38.0	1.00	1.00
Heavy oil, 2½ gals. per sq. yd.	.0239	1.37	27.3	.77	.77
Thin oil, 2½ gals. per sq. yd	.0329	1.08	7.3	1.00	.80
Earth (no lining)	.0329 / .0355 / .0330	1.00	0.00	...	...

*Excluding the preparation of the ditch.

[†Evidently this is the estimated cost for regular rather than experimental work.—Ed.]

dered. This report suggests the tentative adoption of several minor improvements to increase the capacity of the subway during the rush hours. The principal one, and in fact a fundamental one in any case, is to limit the length of station stop of the trains. The present operation calls for a maximum of 30 trains per hour, i. e., 2-min. spacing of express trains. This cannot be realized, as the operation is conducted at present, because the station stops exceed 45 sec., which is the limiting value for maintaining 2-min. spacing. The side-door car is most likely to relieve this condition, by making possible quicker traffic interchange. But as a present expedient Mr. Arnold suggests that the station platform guards be instructed to limit the stop of trains to 45 sec. by having the gates closed no later than 40 sec. after the train stops. Some changes in block signals just ahead of stations are recommended, to permit an approaching train to start pulling in before the preceding train has quite cleared the platform. This latter suggestion, however, is not free from danger.

The condition of overcrowding in both surface cars and rapid-transit cars in large cities, and its effect in reducing the traffic capacity of such lines, receives a sidelight in a recent interview with the managing director of the London United Electric Tramways Co., published in the New York "Times." He said:

In London we are allowed to carry 35 passengers inside and the same number on top, but not one over. . . . . The electric cars, I believe, are licensed under an old act passed in 1832 to deal with stage coaches and intended to prevent the overloading of horse-drawn vehicles. . . . . I have never seen the crowd that I could not handle. . . . . The London public would never stand for the crowding and swinging on straps as New Yorkers do. If there is no room they wait for the next car, that's all.

THE WATER POWER ELECTRIC PLANT belonging to the Sanitary District of Chicago began operation on Nov. 26. The plant utilizes the water power of the Chicago drainage canal and has cost about $4,000,000 for installation. It is estimated that when a flow of 10,000 cu. ft. per second or 600,000 cu. ft. per minute is reached, the annual revenue from the sale of current will reach $726,000. Contracts for the supply of current have been made with the City of Chicago, the West Park Board and towns outside the Chicago city limits.

A DISASTROUS COAL MINE EXPLOSION occurred near Fayette, Pa., on the night of Dec. 1, when accumulated gas in the Naomi mine of the United Coal Co. was ignited, it is thought by a careless miner entering an old working with an open lamp. Press reports vary as to the number of deaths, but later ones state that at least 49 men were killed—mostly through suffocation. The little mining village of Naomi, at the mine, lost all of its adult male population but 18 men. The explosion was a violent one, the concussion shaking up Fayette and other near-by towns.

Fire in the Fremont mine, at Drytown, Cal., imprisoned 11 men on Nov. 30. Despatches dated Dec. 2 state that the mine was still burning and that all hope of rescuing the men had been abandoned.

IN A WRECK ON THE BALTIMORE & OHIO R. R. at Shenandoah Junction, W. Va., on Dec. 2, three persons were killed and 12 injured. The eastbound St. Louis and New York express was "sideswiped" by the derailed cars of a freight train that had just been run into by another freight train as the express was passing at high speed. The locomotive and first three coaches were only scraped; but the fourth car, a day coach, was thrown from the track and overturned.

Five persons were killed and 6 seriously injured at Waterbury, Conn., on Nov. 29, when an extra freight train on the New York, New Haven & Hartford R. R. struck a Waterbury electric car at the West Main St. grade crossing. The car was struck broadside. A gateman's error is said to have been the cause.

A FATAL EXPLOSION occurred on Nov. 21 in a gelatin mixer building of the E. I. Dupont De Nemours Powder Co.'s plant at Hercules, Cal. Two men were blown to pieces and the mixer building was demolished. The cause of the accident is not reported.

This is the third serious explosion that has occurred in the plants of the company within a few weeks, the disaster at Fontanet, Ind., and that at Bradner, Ohio, being still fresh in the public memory.

On Nov. 25 Coroner R. H. Leavitt filed, at Terre Haute, Ind., his verdict in the case of the Fontanet explosion. In part, the coroner's verdict was as follows:

From all sources of information I was able to determine as follows: That on the morning of Oct. 15, 1907, the glaze mill exploded. This was followed by the powder magazine, and this by other parts of the factory. Finally, about fifty minutes later, the dynamite magazine was exploded. The powder magazine, containing as it did a large quantity of powder, caused by far a greater per cent. of the deaths, injury and damage. . . . . This factory was operated with utter lack of regard for human life or injury to others. They were making about 1,800 kegs of powder daily and maintained a magazine with from 30,000 to 40,000 kegs of powder, which could and did explode with such disastrous results. The magazine was located at such a short distance from all the other units of the factory that it made each and every man employed at the mercy of any other employee and an act of ignorance or negligence of one could kill or injure all.

The powder company had evidence in the explosion of the press mill on Jan. 20, of this year, that fire could and would be carried to other units of the factory; but in the face of such evidence the company was constructing, and had nearly finished at the time of the October explosion, another press mill, which was about half the distance away, thereby increasing the danger of complete destruction.

The company maintained a keg factory, which employed 10 men. Of these 2 were killed and the others injured. This factory for making kegs should have been located entirely away from the factories in which the powder was made, and saved men at an ordinary occupation from the danger. There was no reason or excuse for its being situated where it was, except to reduce the cost of kegs, with no regard for the men employed. There were two men each in the engine and boiler-rooms; in each of these there was one man killed and one injured.

The power was transmitted through dynamos, electric wire and motors to each unit of the factory which made it unnecessary to have these situated in the danger zone.

. . . . . .

The cause of the explosion was the imperfect action of, or accident to, some part of the machinery used in the glazing of powder. Fire was thrown from this to the powder magazine, which exploded a few seconds later. These were followed by the press mill, wheel mills, packing-houses and finally by the dynamite magazine, which exploded after a portion of it had burned. The two corning mills, which were located at the extreme northeast of the plant, did not explode.

The amount of powder which exploded was 30,000 to 40,000 kegs of blasting powder (25 lbs. to the keg) and about 30,000 lbs. of dynamite. The powder was contained in the magazine, packing house, press mill, wheel mills and glaze mill. About 1,500 to 1,800 kegs of this powder were in process of manufacture, there being 1,000 kegs in the glaze mill at the time. The dynamite was contained in a magazine about 200 ft. from the powder magazine.

The number now dead from the explosion is 27. Twenty-five died the day of the explosion; one from tetanus, on Oct. 23, and another on Nov. 8, 1907. The number of injured was perhaps 125; 100 of these were in no way connected with the manufacture of powder. The property loss will exceed $375,000, including the total loss of the powder plant and from a partial to complete loss of each and every building in the town of Fontanet.

Four men were killed and three injured on Nov. 19, at a railway construction camp near Cheney, Wash., by an explosion resulting from thawing dynamite beside an open fire.

THE KARATAGH EARTHQUAKE, in the province of Bokhara, Russian Turkestan, which we noted on Nov. 7, p. 505, appears to have been far more disastrous than the later press despatches at that time seemed to indicate. A cable despatch from London, published in the Washington "Star" of Nov. 1, is based on the letter of a correspondent to a London publication, and states that fully 12,000 human beings perished—4,000 in the town of Karatagh alone—and over 25,000 head of live stock. The letter of this correspondent is in part as follows:

On the eve of the disaster, Oct. 20, a terrific storm burst over Karatagh and its environments. . . . . Early in the morning the whole town seemed to shudder. The earth tremors were frequent, but few of the townspeople were sufficiently disturbed by them to leave their houses.

Fifteen minutes later a terrific shock set the entire place swaying, the air resounding with weird noises. Then the town seemed to be repeatedly lifted high in the air and set down heavily. Buildings were crumbling and crashing to ruins every moment or two. In scores of places the ground burst open and boiling water spouted upward. Huge fragments of rock became dislocated from the surrounding mountains and added the thunder of their fall to the subterranean rumblings and roarings which continued all the time. Numerous houses were battered down by the falling rocks. Others, with their occupants, sank bodily into great fissures in the earth.

. . . . . .

In the meantime similar scenes were being enacted in the surrounding country, twelve large villages being destroyed on this same morning. So died in all some 12,000 persons. In Karatagh alone 2,000 bodies were recovered. As many more still remain in the ruins of 1,200 houses, while 25,000 animals, on a rough estimate, were destroyed.

A REMARKABLE LAUNCHING ACCIDENT took place at the shipyard of the Società Esercizio Bacini at Riva Trigoso, near Spezzia, Italy, on Sept. 22. The "Principessa Jolanda," a new trans-Atlantic passenger steamship for South American trade, had been built on the ways, and engines, boilers, superstructure, masts, etc., had been installed before launching. When launched, as soon as the vessel was fully in the water it listed to port, and, gradually heeling over more and more, soon turned over flat on its side and sank to the bottom, resting in about 45 ft. of water. The time elapsed between cutting loose and final sinking was not more than 20 mins. The accident is not yet fully explained. The fact that the ports were open perhaps enabled the vessel to take water and gradually turn over when once the first heavy list was established, but no explanation has been made of why the boat listed as soon as launched instead of riding on an even keel. It seems that the ballast tanks were left empty, as the weight of superstructure and machinery brought the launching weight up quite high. This may have produced insufficient stability, but if this be the case it seems remarkable that the stability of the vessel in the actual launching condition had not been investigated before the launch. The vessel is about 490 ft. long, 56 ft. broad, and 37 ft. deep, with a gross tonnage of 9,100 and a designed displacement of 12,000 tons. The engines were two quadruple-expansion reciprocating engines, developing 10,000 HP., and designed to give a speed of 18½ knots. The launching weight was about 7,300 tons (English).

TYPHOID FEVER STATISTICS FOR WASHINGTON, D. C., for the year ending June 30, 1906, are given and commented upon by Dr. William C. Woodward, Health Officer, in his report for the year named, as follows:

In only 1,092 of the reported cases was it possible to obtain information concerning the origin of the disease; 202 of these cases were attributed by the health department to sources outside of the District of Columbia. Of those cases which had their origin within the District 5.75% were attributed to direct contact and 6.63% to milk infection. In 87.64% the health department was unable to assign the case to any known point or species of infection. The cases attributable to milk infection were due to two outbreaks, one of which was responsible for 11 cases and one for 23 cases. Of the patients who apparently contracted typhoid fever in the District of Columbia from sources other than direct contact and milk, 84.6% used Potomac River water exclusively prior to the onset of the disease; 8.6% used Potomac and other waters; 4.4% used well water; 1.1% used spring water, and 1.3% used bottled waters. The department is, however, without information to show what percentage of the entire community during the period when these cases were contracted used each of the several sources of the water supply above mentioned.

A HIGH RAILWAY VIADUCT was completed on the Pittsburg, Shawmut & Northern R. R., in southwestern New York, a few days ago, replacing a wrought-iron viaduct built in 1883, which had become too light for the traffic. The viaduct crosses the gorge of Stony Brook, south of Wayland, N. Y., and is 640 ft. long and 242½ ft. high from water level to rail. The new structure was built alongside the old one, which involved slight change of approaches, but maintained traffic without interference. It is composed of 40-ft. towers 80 ft. apart in the clear, with plate-girder spans and tower girders. The abutments have a face height of 50 ft., and they as well as the piers are of concrete. The steelwork weighs about 600 tons. The roadbed is laid with 85-lb. rail and 56-lb. inside guard-rail. The construction of the viaduct, including masonry and earthwork, occupied less than 9 mos. It was given a load test on Nov. 26 by a double-headed train of loaded coal cars, which was run across at various speeds, and stopped by emergency brake application when on the bridge. The bridge was built by the Pennsylvania Steel Co., but was designed by Mr. Wm. B. Parsons as Consulting Engineer for the railway company. The substructure and earthwork were done by the railway company, under H. S. Wilgus, Engineer of Maintenance-of-Way.

A REINFORCED-CONCRETE BRIDGE, consisting of four flat elliptical arches, each 70 ft. long, is now being erected on the line of Mission Ave. in Spokane, Wash. The arches are of the solid arch ring type, designed according to the elastic theory under dead loads of 150 lbs. per cu. ft. for concrete and 120 lbs. per cu. ft. for earth filling, and 200 lbs. per sq. ft. for live load taken over half the arch. Maximum fiber stresses were determined for 20 points on the ring under the above loads and under a change of temperature of 40° F. each way from normal, with the following limits as to stresses:

Modulus of elasticity of concrete.....	1,500,000
Modulus of elasticity of steel.....	30,000,000
Maximum Compression Allowed on Concrete:	
Exclusive of temperature stresses.....	500 lbs. per sq. in.
Including stresses due to ± 40° F. variation in temperature	600 lbs. per sq. in.
Maximum Tension Allowed on Concrete:	
In arches, exclusive of temperature stresses	50 lbs. per sq. in.
In arches, including stresses due to 40° F. variation in temperature.....	75 lbs. per sq. in.
In slabs, floors, walls and posts.....	0 lbs. per sq. in.
Maximum shear allowed on concrete..	75 lbs. per sq. in.

The steel ribs were designed to take the entire bending moment of the arch without aid from the concrete up to allowable stresses of 18,000 lbs. per sq. in., although the total calculated stress in the steel did not at any point rise above 7,000 lbs. per sq. in. Where walls and posts were subjected to compression only, no allowance was made for the strength of the embedded steel, which was employed in such members only as a safeguard against cracks which might develop with change of form due to changes in temperature or to shrinkage.

Provision for expansion has been made by cutting the spandrel walls over the abutments in a plane perpendicular to the longitudinal face of the wall; no tongue-and-groove joint was used. The architectural treatment of the bridge has been a matter of some study, especially at each pier where column-like buttresses extend from the plane face of the masonry out into the river.

The bridge was designed by Mr. Charles McIntyre, City Engineer of Spokane, who has furnished us the above information, and Mr. Arvid Reuterdahl, Assistant City Engineer, with Prof. W. H. Burr as Consulting Engineer. Its estimated cost is $55,000.

INTERMITTENT FILTRATION AND TRIPLE AERATION of water, as used at Springfield, Mass., to free the water in the notorious Ludlow Reservoir from odors and tastes, is described by Mr. Elbert E. Lochridge, Assoc. M. Am. Soc. C. E., Chief Engineer of the Springfield Water-Works, in the course of an article published in the Journal of the New England Water-Works Association for September, 1907. We quote two paragraphs from the paper, as follows:

This filter as designed was to be of sand, put in by analysis only and not by washing, directly from the sand-banks near the site of the filter. The water was to be pumped upon the beds and the usual height of the reservoir used for pressure in the city as heretofore. These filters cover practically four acres in extent and are of a depth of 5 ft. of sand over tile underdrains laid directly on the subgrade, with no concrete or other bottom. These are all connected into a main central drain, which carries the filtered water out to the clear water reservoir or basin, which, before the construction of the filter, was the controlling basin for the city. The filter was operated through the season of 1906 and furnished very satisfactory water. It is designed to give aeration before the water is delivered to the filter bed, so that even though the regular reservoir water is highly charged with organic matter and has but little dissolved oxygen, it will be thoroughly aerated. Following the filtration, it falls from the lateral drains into the central drain and again from the central drain into the basin, giving in each case an additional aeration following filtration. This was to rid it of any odors which would pass the filter, and also give a well-aerated water for use.

In addition to this the beds are operated intermittently, that is, for 16 hours or longer if necessary to furnish the supply, but on an average of about 16 hours each day, and then the beds are allowed to rest and to have air drawn through them so that the sand will become filled with air and in this way supply additional oxygen to the beds. In this the lesson, learned from the earlier experiments, that aeration was one of the essential features of the purification of this water, was made use of.

PERSONALS.

Mr. G. C. Killeen, Master Mechanic of the New Jersey & Pennsylvania Traction Co., of Trenton, has resigned.

Mr. W. S. Hall, Vice-President and General Manager of the Lehigh Valley Transit Co., of Allentown, Pa., has resigned.

Mr. C. E. Stewart has been appointed General Superintendent of the Gadsden plant of the Southern Steel Co., succeeding Mr. W. E. Nichols.

Mr. R. E. Watson, President of the Columbus (Miss.) Ry., Light & Power Co., has resigned. The vacancy was filled by the election of Mr. C. F. Sherrod.

Mr. H. L. Jones, formerly Australian representative of the Carnegie Steel Co., has been made Mexican representative with headquarters at Mexico City.

Mr. J. W. McFarland, formerly General Superintendent of the Chattanooga Electric Ry. Co., has been appointed to the same position with the Macon (Ga.) Ry. & Light Co.

Mr. R. E. Burriss, Superintendent of the Anderson (S. C.) Traction Co., has resigned. The vacancy is filled by Mr. L. R. Nelson, formerly of the General Electric Co.

Mr. Robert N. Dickman, M. Am. Inst. M. E., of Chicago, has been appointed Consulting Engineer of the Consolidated Zinc Co., with office in the Borland Building, Chicago.

Mr. C. T. Norton has resigned as Superintendent of the Mexican International R. R. at Ciudad Porfirio Diaz, to become Superintendent of the Coahuila & Pacific division of the Mexican Central Ry. system.

Mr. S. M. Felton, President of the Chicago & Alton Ry., has been elected President of the Mexican Central Ry., to succeed Mr. Eben Richards, who has been holding the office temporarily since the resignation of Mr. A. A. Robinson.

Mr. J. W. Sanger has been appointed Supervisor of Material for the Lake Shore & Michigan Southern Ry., the Lake Erie & Western R. R. and the Lake Erie, Alliance & Wheeling R. R., with headquarters at Collinwood, Ohio.

Mr. W. A. Cornelius has been appointed Manager of the National Department of the National Tube Co., succeeding Mr. Geo. G. Crawford, whose election to the presidency of the Tennessee Coal, Iron & R. R. Co. we noted on Nov. 21.

Prof. Robert B. Brinsmade, M. Am. Inst. M. E., has been made President of the newly organized mining school at Platteville, Wis. Prof. Brinsmade is well known in western mining circles, both as an educator and as an engineer.

Mr. Jas. F. Jackson has resigned as Chairman of the Massachusetts Railroad Commission, to engage in private law practice in partnership with Mr. Herbert Parker, former Attorney-General of Massachusetts, and Brig.-Gen. Hugh Bancroft.

Mr. L. G. Morphy, Assistant to the Principal Assistant Engineer of the New York Central & Hudson River R. R. at New York City, has been appointed Assistant Engineer of Maintenance of Way and Construction of the Boston & Albany division of the road, with headquarters at Boston.

Mr. G. M. Dyott, Assoc. Am. Inst. E. E., an engineer with the Westinghouse Electric & Mfg. Co., of Pittsburg, has resigned to open an office for consulting work, in the Westinghouse Building, Pittsburg, specializing in electric locomotives and electrically-operated mining machinery.

Messrs. H. V. Wallace, M. Am. Inst. M. E., and H. Gordon Glore, M. Am. Inst. M. E., of Nogales, Ariz., and Mr. Maurice W. Summerhayes, of Kent, England, have opened offices at Nogales as consulting mining engineers and metallurgists, under the firm name of Wallace, Glore & Summerhayes.

Mr. J. M. Johnson has been elected a Vice-President of the Missouri Pacific Ry. and St. Louis, Iron Mountain & Southern Ry., with headquarters at St. Louis. Mr. E. B. Boyd, Manager of the transportation department of the Chicago Board of Trade, succeeds Mr. Johnson as assistant to the vice-presidents of the Gould lines, with office at Chicago.

Dr. Robert Bell, Chief Geologist of the Geological Survey of Canada, was the Guest of Honor at the semi-annual dinner of the "Canadian Camp" in New York City on Nov. 18. The camp is a social organization made up of men who have spent more or less time camping in the Canadian wilderness. In his address before the Camp, Dr. Bell stated that in his long service of the Canadian Government, he had made over 6,000 different camps.

Mr. Wm. F. Goltra, Chief Clerk of the purchasing department of the Lake Shore & Michigan Southern Ry., the Lake Erie & Western R. R. and the Chicago, Indiana & Southern R. R., has been appointed to the newly-created position of Tie Agent of all New York Central lines west of Buffalo, with headquarters at Cleveland. Mr. Goltra will supervise the inspection and buying of ties for 8,000 miles of road—a duty which has hitherto been performed mainly by engineering officials.

Obituary.

Everett B. Webster, of New York City, President of the National Steel & Wire Co., died at Jacksonville, Fla., on Nov. 29, at the age of 38.

William Wharton, Jr., President of William Wharton, Jr., & Co., of Philadelphia, makers of street railway material, died at his home in Germantown on Nov. 26 at the age of 78 years. He was the inventor of the Wharton switch, at one time in extensive use on steam railways.

Gustav Anton Zeuner, widely known for his studies in thermodynamics, turbines and steam engines, died at Dresden, Germany, on Oct. 17, 1907. He was born on Nov. 30, 1828, and was therefore nearly 79 years old at the time of his death. Professor Zeuner was a member of the original teaching staff of the Zürich Polytechnikum when it began its life in 1855, and he remained there until 1871. He was Director of the college in 1865-1867. In 1871 he was called to Germany, and his subsequent instructional career was spent there.

James H. De Graff, a well-known contractor, dropped dead in Buffalo on Nov. 27 at the age of 73. Mr. De Graff supervised the enlarging of the Erie Canal in 1854; built the Great Western R. R. between Chatham and Belle River, Ontario, in 1856; had charge of the construction of the Chesapeake & Albermarle Canal in Virginia in the same year, and was supervising river work on the Kanawha when the Civil War began. In 1861 he came north and engaged in the lumber and banking business, which he continued for nearly half a century.

Bernard James Harrington, Professor of Chemistry at McGill University, Montreal, died on Nov. 29. He was one of Canada's leading scientists, and had done much to advance Canadian mining industries. Prof. Harrington was born at St. Andrews, P. Q., in 1848, and graduated from McGill in 1869 with high honors. In 1871 he received the degree of Doctor of Philosophy from the Sheffield Scientific School of Yale University and the prize in mineralogy. In the same year he became a lecturer in chemistry at McGill. He was prominent in the service of the Geological Survey of Canada, from which he retired in 1879. Prof. Harrington was a member of the American Institute of Mining Engineers; the American Chemical Society, and of the Natural History Society of Montreal, of which he was a former president.

Chandler C. Coats, formerly Master Mechanic of the New York and Philadelphia division of the Pennsylvania R. R. for 43 years, died at his home in Newark, N. J., on Dec. 2 in his 82d year. In 1862 he became Master Mechanic of the New Jersey R. R. & Transportation Co., and continued in its service after it became a part of the Pennsylvania system, until he retired from active service in 1904. His work during the latter part of his service for the company was connected with the harbor improvements of the New York terminal of the road. He was responsible for many improvements on draw, ferry and transfer bridges, and was an expert designer and builder of truss bridges. Thirty years ago, when the New Brunswick bridge of the Pennsylvania over the Raritan River was destroyed, he had a temporary structure erected in three days. His wife, one son and four daughters survive him.

Francis Hodgman, one of the old-time surveyors, died at his home in Climax, Mich., on Nov. 22, at the age of 68. He was born in Climax, and was educated in the public schools. He entered the Michigan Agricultural College in 1859, graduating in 1862 with the degree of B. S., and three years later with the degree of M. S. In 1868 he was appointed County Surveyor of Kalamazoo County, which office he held until 1893, when failing health compelled him to abandon active field work in his profession. During that time he was engaged for about a year in location and construction of the Marshall and Coldwater R. R., and a similar length of time in the location and construction of the Rio Grande Western R. R. through the Wasatch Mountains in Utah.

Mr. Hodgman was one of the founders of the Michigan Engineering Society, in 1880, and later, under the auspices of that society, he wrote a treatise on land surveying, which he published in 1886, and which is now recognized as the standard authority on questions in land surveying. He was elected Secretary and Treasurer of the Michigan Engineering Society in 1886 and held this office until 1906, when he was elected its President. He has contributed a great many articles to the engineering and agricultural papers. A widow, two daughters, and a son survive him.

ENGINEERING SOCIETIES.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Dec. 5-7. Convention at Chicago. Secy., C. R. Richards, Columbia University, New York City.

ASSOCIATION OF TRANSPORTATION AND CAR-ACCOUNTING OFFICERS.
Dec. 10. Annual winter meeting at Chicago. Secy., G. P. Conard, 24 Park Place, New York City.

ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 14. Annual meeting at Nashville. Secy., John Wilkes, Berry Block, Nashville.

GEOLOGICAL SOCIETY OF AMERICA.
Dec. 16. Annual meeting at New York City. Secy., Dr. E. O. Hovey, American Museum of Natural History, New York City.

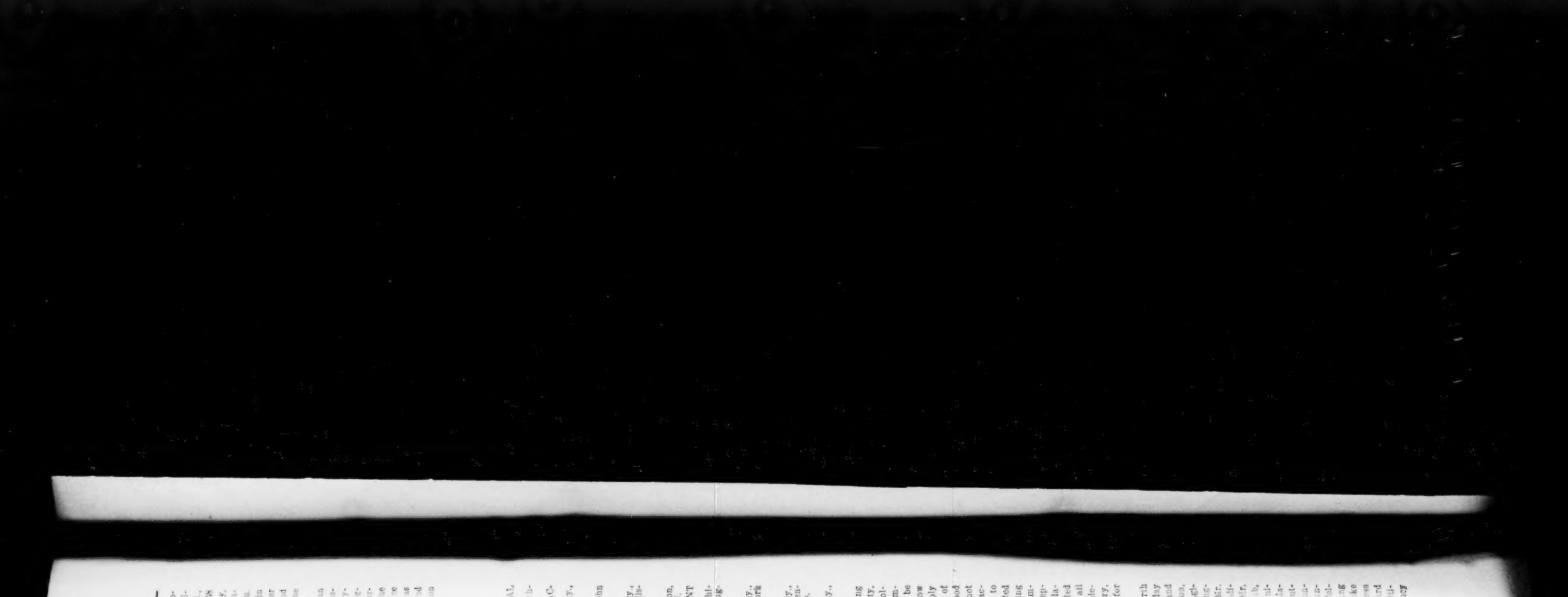
AMERICAN ECONOMIC ASSOCIATION.
Dec. 28-31. Twentieth annual meeting at Madison, Wis. Secy., Winthrop M. Daniels, Princeton, N. J.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 30-Jan. 4. Annual meeting at University of Chicago. Secy., L. O. Howard, Cosmos Club, Washington, D. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 15. Annual meeting at New York City. Secy., Chas. Warren Hunt, 220 West 57th St., New York City.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 20-25. Fourth annual convention at Buffalo. Secy., W. W. Curtis, 585 Caxton Bldg., Chicago. Convention Manager, Dal H. Lewis, 760 Main St., Buffalo.

WOOD PRESERVERS' ASSOCIATION.
Jan. 21. Fourth annual meeting at Kansas City. Secy., C. W. Berry, Laramie, Wyo.

WOOD PRESERVERS' ASSOCIATION.—At the coming fourth annual meeting in January, at Kansas City, headquarters will be at the Baltimore Hotel. The following topics have been assigned for discussion. (1) Impurities of foreign matters in creosote oil that should be avoided. (2) Cylinder cars, tracks, and guard rails; how they should best be constructed. (3) Should the supply tank be overhead or under ground? (4) Best methods of measuring oil. (5) Best method of impregnating wood with preservatives of ordinary use, when pressure is not available. (6) Method of treating wood that is refractory to treatment, and at the same time very subject to decay. (7) Results thus far accomplished in the United States in preserving wood. (8) Best method of treating piles to use in southern waters. (9) Can freshly-cut timber be well treated, and how? (10) Best method of keeping records of treated ties in the track. (11) Compilation of various data in reference to the life of treated timbers, especially ties, in the United States under all treatments. (12) Best practice of treating butts of telegraph, telephone and signal poles. (13) Is it necessary, practical or otherwise, to correct oil measurements for temperature?

TECHNOLOGY CLUB OF SYRACUSE.—The fourth annual banquet was held at the Yates Hotel on Tuesday evening, Nov. 26, at 8 p. m. About 120 members and guests were present. Dr. Frederick Remsen Hutton, President of the American Society of Mechanical Engineers, and Mr. Walter C. Kerr, President of Westinghouse, Church, Kerr & Co., were guests of the club. Mr. Thomas H. Mather, Chief Engineer for the Beebe Syndicate, acted as toastmaster. Mr. Mather introduced Mr. Edward N. Trump, President of the Technology Club, and Vice-President of the American Society of Mechanical Engineers, who addressed the club in a congratulatory way regarding its growth and possibilities. Dr. Hutton was then introduced. In a concise, logical and convincing address he discussed "The Engineer of the Twentieth Century; His Work and Training." Mr. Kerr followed with practical remarks pertaining to "Engineering Progress." Members of the club who afterwards spoke were the following: Prof. John E. Sweet, "The Progress of the Artisan School"; Prof. William Kent, "Hard Times"; Mr. John H. Barr, "The Engineer as a Citizen"; Mr. Henry C. Hodgkins, "The Financial Stringency and the Engineer."